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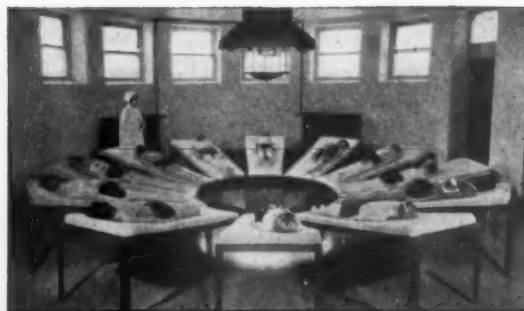
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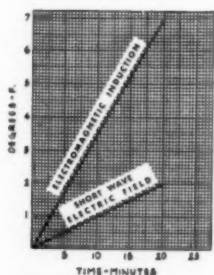
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THE CONDENSER FIELD

An Improved Method of Application

FRANZ NAGELSCHMIDT, M.D.

LONDON, ENGLAND

It was but natural that the first investigators of ultrashort high frequency currents concentrated their main interest on the condenser field. This in part was doubtless ascribable to the striking effect in the therapeutic application of the condenser field. This led to the neglect of other possible applications with resulting limitation of their observations of specific effects different from and even opposite to those produced by diathermy.

In 1922, I began the study of short waves by means of an electron-tube, but the results were negligible because at that time I could not obtain appreciable intensities. In 1926, at the invitation of Dr. Kobak, of Rush Medical College of the University of Chicago, we performed at that institution a series of experiments with an 86-meter wave apparatus made available to us by the H. F. Fischer Company of Chicago.

The condenser field in the form of condenser couches or condenser chairs as well as condenser electrodes with vacuum or graphite filling represents one of the oldest methods of application of high frequency currents. As regards this field its efficiency was recognized since the advent of high frequency currents in medical practice. Heating effects have been observed with the condenser couch by Apostoli, who placed the patient on a big metal plate covered with an insulating material, one pole of the apparatus being connected to the plate, the other to a hand electrode. A distinct heating sensation in the wrists and a slight rise of temperature of the whole body were observed. In 1910, I enhanced this effect by a similar method by replacing the hand electrode with a net connected to the other pole of a powerful high frequency apparatus of four Leyden jars.* This metallic net was insulated by rubber sheeting. The heat produced was sufficiently intense to kill in a short time dogs and rabbits which had been wrapped in

cotton wool. This was the first demonstration of displacement currents between two insulated electrodes in a condenser field.

In this respect the condenser couch of Schittenhelm, who subdivided the metal plate of the couch into four equal parts, covered by an ebonite plate, and put the patient on top of it, proved less efficient. The four parts could be connected in different ways to the two terminals of a diathermy apparatus, producing a sufficiently high tension. I shall later discuss the short wave condenser field produced by plates situated in the same way. It should be pointed out that one pole connected to a large condenser electrode used as a couch, or a smaller one to be put on the seat of a chair, has been used for the past 20 years by myself and others as the indifferent electrode for diverse diathermic applications. The physician connected to the other pole could apply diathermic massage and manipulations by touching the patient. By connecting the other pole to a metallic instrument one could perform with it surgical coagulation. This resembled a monopolar surgical diathermic operation, but in fact was a bipolar one, the patient being connected to the other pole by the condenser field of the seat or couch electrode. Disrobing by the patient was obviated. The disadvantage of these primary forms of application of the condenser field was the relatively low intensities and high tension necessary to produce a strong field with long wave diathermy.

The shorter the wavelength the more the condenser field, that is to say, the displacement current becomes intense, so that with a wavelength below 200 meters local and general heating is obtained.

Action of Different Wavelengths

All attempts to compare short wave diathermy (which in my opinion is synonymous with the short wave condenser field or displacement currents) with long wave

* Without resonator.

diathermy as applied with direct contact metal electrodes are illogical. To compare the effects of the different wavelengths we must evaluate them by the same form of application. If this is done we need not be surprised to find that the effects of these applications will show differences in quantity but not in quality.

The direct application of plate electrodes with short waves is possible, but must be made with great care. Incomplete adaptation may cause a severe burn, and as the spark of the short wave diathermy easily produces a strong flame, the risk is obvious. This objection can be readily overcome by placing a piece of rubber sponge or moistened gauze between the electrodes and the skin, as is advocated also with ordinary diathermy. Such an application is free of risks and can be employed both experimentally and clinically. To determine in what manner short wave diathermy applied by plate electrodes is distributed along the tissues, I studied experimentally and clinically the form and extension of the coagulation zone in pieces of bread, meat, bone, different other organs, living animals, etc. These experiments show that diathermy of different wavelengths from 500 down to 2 meters shows exactly the same characteristic coagulation. The only difference is that the shorter the wavelength the more equal is the depth effect. This is to be interpreted that the degree of coagulation from the surface through the entire zone in depth is more equal with the shortest waves, while with long waves it is difficult to coagulate equally at a depth of about two inches without carbonizing the surface. Carbonization is avoided with 2 to 30 meters wavelengths. The difficulty with these experiments is, that we have no exact measure of the energy utilized and cannot well compare the relative intensity of the currents of different wavelengths. If, however, we take into account the experience, as pointed out in my textbook of diathermy in 1913, that great intensities applied for a short time have a more superficial effect and smaller intensities applied for a long time produce deeper effects, we may deduct that the same holds true also for short waves in their direct application by plate contact electrodes.

Another difficulty for comparison lies in the fact that with diathermy apparatus both

poles conducting the current to the patient are equal. In the short and ultrashort apparatus which I had an opportunity to examine, there is always a very marked difference in the efficiency of the two poles. In all these apparatus one pole is taken from or near the end of the secondary circuit which is grounded or unequally balanced and produces a much greater activity of the other pole. The industry should in future try to overcome this drawback by better balancing the output of the two poles for the patient's circuit.

There is a general uniformity of distribution of any high frequency current in tissues with different kinds of application by means of plate contact electrodes. It is the same for all wavelengths, whether we apply the electrodes parallel to opposite sides of a piece of meat or at an angle to each other or on two adjacent sides of a cube, even with electrodes of different sizes. To illustrate, I took a piece of ox muscle with parallel fibers containing no visible fat or fascia. I cut up three equal pieces three and one-fourth inches long and two by three inches wide. The electrodes were applied parallel to the opposite small sides; thermometers were inserted from the top surface to the middle plane, one inch deep, at 0.3, 1, 1.5 and 1.9 inches from the left edge (fig. 1). Table 1 shows the result. We

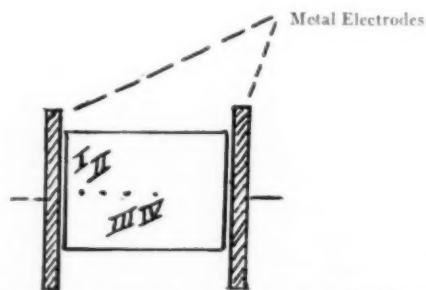


Fig. 1. — Bloc of meat exposed to the short-wave condenser field. I-IV indicates the place of insertion of the four thermometers seen from above.

observe with weak diathermy currents (wavelength 500 meters) 81 per cent of depth effect, with medium currents 80 per cent and with strong currents 76 per cent. A second piece was examined with 6 meters wavelength and showed with a weak current intensity 88 per cent of depth effect and with a strong current 83 per cent. A third piece examined with a wavelength of

TABLE 1.—The Percentage of the Temperature-Rise of Thermometer IV. (Near the Centre, cf. fig. 1) as compared to the Rise of Temperature of Thermometer I (Near the Edge), Valued as 100, Is Called "Deep Effect."

Wave-length in Meters λ	Deep Effect			Duration of Application in Minutes	Average Deep Effect in % of the Superficial Effect
	Weak	Medium	Strong		
500	81%	80%	79%	35	80%
30	87%		71%	20	79%
6	88%		83%	15	86%

30 meters showed with weak currents 87 per cent of depth effect, with strong currents 71 per cent. As already mentioned, there is no possibility for equal dosage of the different wavelengths. A rough comparison shows that with ordinary diathermy 35 minutes were needed, while with 30 and 6 meters wavelengths the effects were reached within 15 and 5 minutes, respectively.

With a piece of meat with electrodes in form of a disc applied at two adjacent sides, the temperature of the center of the piece was raised in three minutes only by 0.4 degrees, while the edge between the two electrodes and the adjacent section from this edge towards the center was coagulated to a depth of three-fourths of an inch, exactly in the same way as with diathermy (fig. 2). The same holds true for the coagulation zone between small electrodes in a flat dish of egg albumen.

We may conclude that the direct plate application of diathermy, short and ultra-short diathermy shows identical character-

istics, the only difference being that the depth effect is somewhat greater and the whole effect somewhat more equal on the surface as compared with that of depth of shorter waves. Comparative temperature measurements have shown that there is in short wave diathermy a marked difference between the two poles, and that we have to consider the ungrounded pole as the more active one. We shall consider the clinical differences later on.

For surgical operations very short waves do not appear to be promising. With very small intensities minor tissue destructions may be carried out. But with medium currents the effect is so quick and so difficult to localize in depth effect and surface limitation, that proper control is impossible. The tendency to arcing with its undesirable effects, especially encountered on motion of the patient renders this surgical method well-nigh impossible. Furthermore, the insulation of the electrode handle must be extremely thick as otherwise the heat in the surgeon's hand becomes unbearable.

Researches by Schereschewsky, Schliephake and his followers deal mostly with the effects of the condenser field of wavelengths between 30 to 3 meters. On the assumption that the general effects of the condenser field with short waves are known, we may briefly review the following facts.

1. Solutions of different chemical substances brought into the field show maximum of heating effect with certain concentrations as well as with certain wavelengths.

2. Different tissues of organic substances like albumen, fat, organs, etc., are heated at different degrees and times with the same

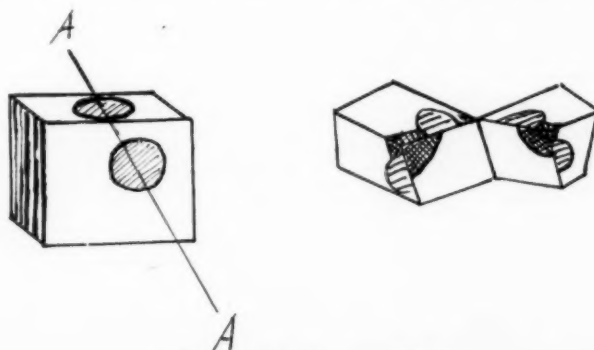


Fig. 2.—A-A before coagulation; and A-A after coagulation.

wavelength and apparently also with different wavelengths.

3. Depth effect is claimed to depend on the more or less close approach of one or both electrodes. The nearer the electrode is to the skin the more superficial is the effect on the concerned side.

4. Claims have been made for specific clinical effects. It is not possible to apply the results of specific heating effects connected with certain concentrations of ions or with a special wavelength to clinical experience. The substance of the body is so complex that neither in microscopic nor even in molecular areas is an equal substratum available. Some authors regard the intracellular liquid as a salt solution. This is not true. Nowhere in the body is there a pure electrolytic solution, except perhaps in some parts of the urinary system.

All the fluids like plasma, lymph, gland secretions contain a considerable amount of colloids, which prevent the application of experimental results with pure salt solutions to body fluids. As with diathermy, the substance of different organs is heated by the same energy to a different degree, and there is no specific difference for the different wavelengths if the organs are heated singly under equal conditions. Only if they are in their normal connection and under physiologic conditions inside the body, are differences seen between long and short waves in that the latter have a slightly greater depth effect. With bone the difference is more marked because it offers a greater resistance to long waves, while short waves by their greater faculty to travel as capacity currents, are better able to penetrate the bone and considerably to heat the marrow.

In many experiments concerning the results of heating of different organs or substances in a condenser field and placed in series, one point of importance has not been taken into account. To clear up this point, we must analyze in greater detail the form of the condenser field and the distribution of the lines of force, that is to say the field energy.

The normal field (air filled) may be considered as relatively homogeneous, between two parallel electrodes of equal form and size and not too distant from each other.

If the apparatus works in resonance, the

whole system strongly radiates: A neon lamp lights up between the electrodes as well as behind them in their vicinity and along the leads. Any object (metallic, dielectric, electrolyte, etc.) deforms the field and does it in different ways depending on the material. It further produces a damping of the radiation of the whole system, which increases with the size of the object, but is considerable only if the objects are comparatively large and in contact with both electrodes. A metallic object brought into the field absorbs a considerable amount of the produced energy and reflects a part of the energy, it pushes the field away so to speak. A dielectric or an electrolyte produces quite another deformation. Lines of force entering the dielectric surface perpendicularly go straight through. But if they strike at another angle, refraction takes place as with light. If the dielectric consists for example of a glass tube filled with the white of an egg, the way of the lines of force deviated by refraction is as shown in Figure 3 (upper part). If we put such a tube of about 4 inches in length and one-half an inch in diameter between two condenser plate electrodes, say of a 5 inch diameter and at 5 inches distance, we observe initiation of coagulation in the center of the tube. This is not caused by the better protection of the center against loss of heat as compared to that of the sides of the tube. The reason is that additional lines of force from the total area of the electrode surfaces enter the tube along its total length from all sides and so increase the density of the lines of force towards the central plane, while the ends of the tube remain practically cool. During the experiment at first a rapid, then slower and at last very slow coagulation takes place extending from the center towards the periphery (fig. 4). Removal of one electrode to a greater distance or a change of size of one electrode produces only a slight difference in the site of the primary coagulation. Neither does a change of the wavelength or intensity produce any other behavior except as to the time of coagulation, owing to the different intensities of energy. This tendency of dielectrics and electrolytes so to speak to attract the lines of force, to refract, to conduct them and to produce different densities of energy at different dis-

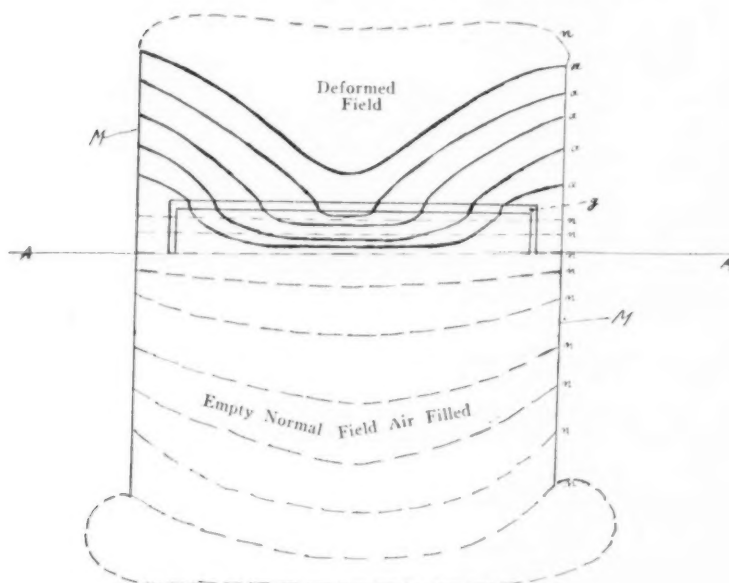


Fig. 3.—There are 2 metal electrodes M. The line A divides the field between the electrodes into an upper and a lower part. For better comparison the dielectric is supposed to be only in the superior part, while the lower part remains empty. The dotted lines n represent the ordinary lines of force. The full lines "a" design the additional lines of force, deviated by the effect of the dielectric.

stances from the electrodes, must be considered in any experiment where objects of more than about an inch in length are placed into the field. We cannot consider as equal the exposure of any large object of the character of a dielectric or an electrolyte to the field according to the above experiment, and this refers to published experiments performed on organs, bacteria, toxins, colloids, etc., with reference to the

surface of the electrodes being greater than the section of the object. In studies of the bactericidal effect of short waves the necessarily unequal heating effect is bound to yield faulty results, if the experimental conditions do not take in account the above described and explained absence of homogeneity of the field, such as is produced by the introduction of a test tube into the field.

Another feature of the simple condenser

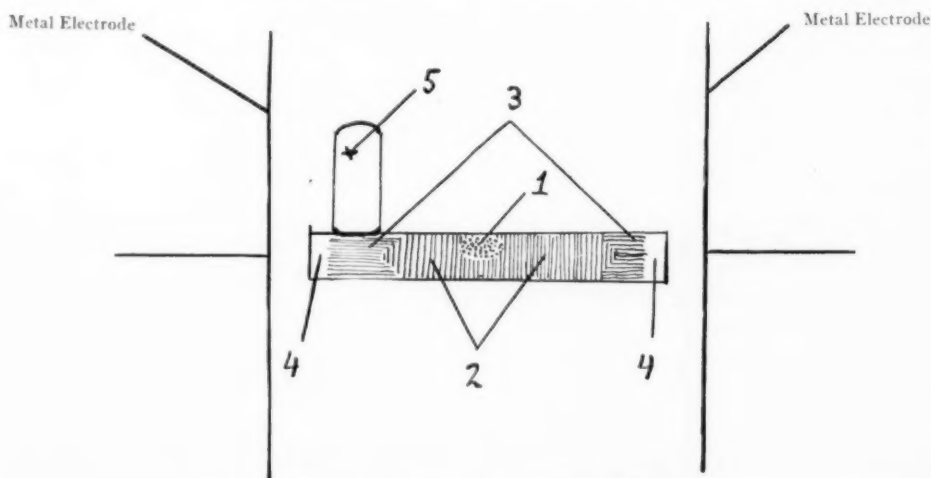


Fig. 4.—Coagulation starts at 1, extends quickly to 2, progresses slowly to 3, while the ends 4 remain cool; 5 is the funnel for filling and expansion.

field application prevents exact evaluation of dosage and comparison of different wavelengths in their physical and clinical efficiency. This pertains to the problem of radiation and leakage of the field which varies with different wavelengths. It is easy to demonstrate by a small neon lamp that all around the electrodes and the leads and partly near the patient or the objects brought into the field the lamp lights up even at a considerable distance. It is therefore practically impossible to state how much of the produced energy actually enters the object exposed to the field, and how much is simply lost by radiation and leakage to all sides, especially to the floor, or to nearby individuals acting as aerials and drawing energy to the ground. Some investigators estimate that in the usual arrangement of the field for treatment only 20 per cent of the available oscillatory energy actually enters the part to be treated and that 80 per cent is lost. This estimate comes very near to the truth. We must consider in the comparison of different wavelengths that the energy concentration in the wave itself (h. v.) increases with the frequency and decreases with the increasing wavelength. This is a strong and not the only argument against experiments concerning the selective specific effect on tumor cells with narrowly defined wavelengths. The actual energy inherent in the different wavelengths has not been and could not be measured, apart from the difference in radiation and leakage losses in the field with different wavelengths.

We must consider that the field distortion changes if we place the same object into the field, but in a different orientation to the electrodes. This relates not only to a greater or smaller distance of one of the electrodes, but to the angle of orientation between the electrodes in the three planes. This is especially important if the objects are asymmetric or provided with sharp edges or protuberances. This can easily be demonstrated by exposing a mouse in different positions to the field. If the exposure is sufficiently intense to produce local effects without killing the mouse, we observe that after a few days a more or less long piece of the tail becomes brittle or is readily lost, one or both ears may fall off or a whole limb or two are destroyed. In one

experiment I had a rabbit suspended in a hammock arrangement with a glass tube in the carotis connected with a kymograph. No metal part was near the animal except two circular electrodes of 2-inch diameter applied near the chest at a distance of 2 cm. Not even a clamp or a pin was used. The registration of the heart beat functioned very well for some time; suddenly it stopped, and the animal was found to be dead, with a very insignificant rise of temperature in the rectum and near the diaphragm, but with a considerable rise in the pharynx. The examination showed that the field had produced its strongest effect not between the electrodes in the chest, but at a distance of about two inches from the upper margins of the electrodes, in the neck of the animal, where coagulation in the jugular vein had caused the death; hence the high temperature in the pharynx.

If we consider all these various points, which prevent localization at will, as we need it for clinical purposes, i.e., the loss of probably four-fifths of the total energy and the incalculable deformation of the field as soon as we introduce any object into it, *it is obvious that this crude condenser field needs modification.*

In a series of many hundreds of experiments with different arrangements and models I have been able to develop a system of electrodes which overcomes the most important of these difficulties. By applying the new system we reduce the radiation of the electrodes and of the leads to a negligible amount, and we conduct and concentrate the field to the very surface of the object or part of body to be treated. We perform this task not by metallic conduction, which would mean replacing the condenser field by plate diathermy with ultrashort waves, but by subjecting the part of the body to be treated to the action of the direct field or the lines of force, thus being enabled to produce the greatest possible depth effect. The close approach of the lines of force to the body section to be treated gives the greatest possible approximation to their passing straight from one electrode to the other, especially if the field-conducting electrodes are in direct contact with the surface of the body. It is also possible to regulate the depth effect according to the ratio of the length of the electrodes

to their surface. The smaller the surface, the smaller can be the length. But account must also be taken of the diameter of the object. The depth effect depends on the ratio of the surface of the electrodes to the total distance from plate electrode to plate electrode comprising the length of the new electrodes and the section of the body.

We leave the description of the theoretic and experimental foundations and the construction of these new electrodes to another paper and only mention here that the crude condenser field application used until now has been modified by this new device to an extent that we have as little loss of energy as with ordinary diathermy, and can localize the condenser field the same as with ordinary diathermy, or short wave diathermy with plate electrodes with the additional advantage of applying a real condenser field.*

Clinical Evaluation

Concerning the clinical aspect, my experiences with the new electrode system are not yet sufficiently advanced to permit definite results. With the primitive condenser field method some differences between the effect of long and short wave diathermy are evidently present. One of the principal claims of the investigators of short wave therapy is its beneficial effect in acute furuncles and carbuncles. As stated in the first edition of my book on diathermy (1913) I have been able to cut short the course of furuncles by long wave diathermy. But there is no doubt that the condenser field application is more agreeable to the patient, as pressure of the electrodes is avoided. In this case, too, the application of the new electrodes is of great use, as direct contact with the furuncle is not needed and the advantage of collecting and concentrating the field to the small area of the furuncle is made possible without interfering with prominent parts of the body, i.e., the ears, the chin, the axilla and the like.

While the difference of long and short wave diathermy in the treatment of superficially seated furuncles is quantitative only, other clinical conditions show an apparently more qualitative differentiation. The

good effects of classic diathermy in angina pectoris are frequently absent in short wave condenser field therapy. The application of short wave therapy in an attack of angina pectoris seems even definitely contraindicated with the usual dosage. A very much smaller dose gives better results. Probably the effects of short wave application show themselves in deeper or other tissue layers than with diathermy. That classic diathermy gives better results has been shown in a number of cases.

Another difference of indications arises in some venous affections. Varicose veins, stasis and congestion in plexus as in the parauterine plexus, thrombosis and chronic inflammation of the veins are contraindications for classic diathermy, but respond favorably to short wave treatment.

These and other similar differences reopen the old discussion about the mechanism by which high frequency currents produce physiologic and therapeutic effects. For classic diathermy the discussion terminated with the generally accepted conclusion, that no proof for special electrical effects could be definitely established, and that the effects depended primarily on the heat produced in different places and depths. This heat produced secondary effects, arterial and capillary hyperemia, increased flow of lymph and plasma, leading to decongestion of congested areas and to better nutrition of the tissues. This in turn leads to a tertiary effect: The local increase of cellular function, and organic metabolism.

We may add a word about the so-called vibration theory, refuted for classical diathermy but now discussed with short wave diathermy. It is true that with high frequency currents metal plates can be caused to produce lower frequencies, even sounds, by superimposed slow waves and effects of phase differences. But it is impossible to transfer such a phenomenon from metal plates with well defined characteristic natural frequencies to the colloidal state of the body, where a very strong damping of any such oscillation of low frequency renders a vibration quite impossible.

Another mechanism for the explanation of short wave effects has been put forward, namely, the bipolar effect. Under the influence of the electromagnetic field any mole-

* The increase of the depth effect by employing the effect of the additional lines of force mentioned above is described in my papers: *Nature*, February, 1935, p. 303.—*Brit. J. Radiol.* 8, 1935.

cules, not only electrically asymmetric ones tend to a certain orientation with regard to the lines of force, showing a positive and a negative pole formation according to the direction of the field. As the field oscillates, the polarization changes constantly, and the two poles are supposed to be put in rotation or oscillation accordingly, which means *production of heat*. So, again, the ohmic, the dielectric and the capacitative resistance and the bipolar effect unite to produce the *primary high frequency effect in biology present with any frequency above say one-half million hertzian waves, namely heat*.

Differences in the biologic effects of this heat are caused by heat production in different layers and by the different amount of heat produced in different molecules, groups of molecules, cells, membranes and organs, depending on their specific heating capacity. This in turn is in close relation to its ohmic resistance, its dielectric and capacitative constant, so that we may conclude that *heat production may be considered as the only primary effect for all frequencies of electrical waves, which we are still justified in designating as diathermic heat*.

In spite of the many experiments published with different models (bread, etc.), by various investigators, in which a considerable depth effect higher than with ordinary diathermy has been demonstrated, clinical experiments on the living body failed to show this depth effect. In accord with Cumberbatch, who stated recently that he could not find a rise of temperature in the vagina by applying the condenser field to the pelvis I also was unable to produce an elevation of the temperature in such a depth by a similar application with the maximum output of a 6-meter Siemens apparatus within half an hour of exposure. It is obvious that the field energy, if an air space of 1, 2 or 3 cm. separates the electrodes from the surface of the body, extends too much around the electrodes as well as inside the tissues to produce any localized heating in depth. For such a purpose, the application of classical diathermy with large sized electrodes and strong currents for a long time gives a better effect in spite of the losses by dispersion and of heat convection due chiefly to the circulation of blood and lymph. A considerable depth ef-

fect can be produced in the condenser field between parallel electrodes only if the surface of the electrodes is greater than the section of the body between them. But even then, with the present condenser field superficial heating prevails. We can overcome this difficulty by placing a patient horizontally on a couch and applying to one or both sides one or two of the new electrodes about 6 inches wide and 18 inches long perpendicular to the side of the couch, so that the long ends above and below may supply additional lines of force along the section of the body to be treated. The electrode connecting the short wave apparatus to one side of this auxiliary electrode can have the form of a small plate of 3 inches diameter or can be square or rectangular, while the auxiliary electrode extends from the other surface of the plate to the surface of the body gradually diminishing in size to a section of, say 4 square inches, at the end touching the body. Figure 5 gives an idea of the shape of the electrode. The depth of the plane inside of the object where the chief heating is desired can be changed by using only one of the new electrodes on one side and the ordinary condenser field electrode on the other, or better by using a shorter or longer auxiliary electrode between the other metal plate and the patient. Specifically the auxiliary electrodes will probably be united to the plate electrode, so that they form one piece. Parts of them will be exchangeable to allow use of different sizes and forms of surface and of different lengths.

Summary

The condenser field in its primitive form is sufficiently effective for a general increase of temperature of the body. Yet it is possible that the new electrodes may aid in developing a system of fever production by localized heating of certain smaller areas. This would require much less energy. Perhaps the output of a smaller apparatus would be sufficient as losses are thus reduced. At present fever is generally produced by large electrodes applied to both sides of the body or by approaching two large parallel plate electrodes at a small distance from each other to one surface of the body. Figure 6 shows this field effect in an experiment with albumen.

For local treatment the condenser field

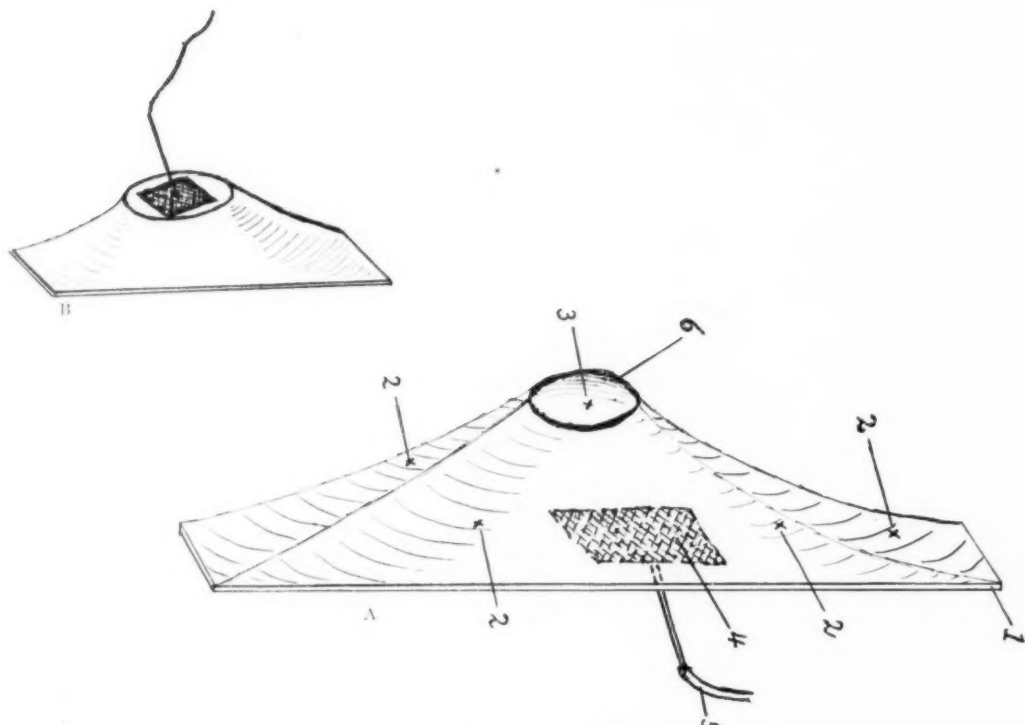


Fig. 5. — A special designed condenser electrode to promote controllable heat at considerable depth.

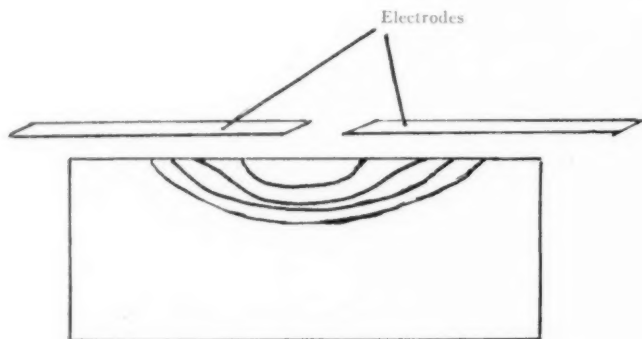


Fig. 6. — Parallel plate electrodes arranged in one plane. Coagulation of egg albumen in a flat dish occurs within 2 cm. under or above the electrodes, starting between the electrodes. The coagulation forms quickly, but only near the interspace of the electrodes, and there is no deep effect. Applied for electrical fever, this is produced by superficially heating the skin and the subcutaneous tissue; herewith the considerable amount of blood contained in and under the skin and flowing through it is heated; thus a general rise of temperature of the whole body is produced.

represents only an insufficient approach to its possibilities. By applying the new device of auxiliary dielectric electrodes more can be attained. We avoid loss by radiation and leakage; we conduct practically the whole energy to the desired site; we increase considerably the efficiency, avoid

deviation of the energy to neighboring places which we do not want to expose to the field (ears, prominent parts) and we considerably increase the depth effect.

This method first renders possible and economic an efficient local and general treatment in a condenser field.

HISTAMINE IONTOPHORESIS IN RHEUMATIC AND PERIPHERAL CIRCULATORY DISTURBANCES *

DAVID H. KLING, M.D.

LOS ANGELES

Signs of abnormal peripheral circulation like cyanotic, cold and clammy hands and feet, are common in various types and stages of rheumatic conditions. Ischemia due to vasoconstriction is according to von Papp⁽¹⁾ responsible for the painful contractions which characterize various forms of muscular rheumatism, such as torticollis, lumbago, myalgia of the shoulder muscles and of the iliotibial bands. Circulatory disturbances due either to vasospasm or inflammatory reaction are important etiological factors in the production of the soft tissue changes in arthritis, contracture and atrophy of muscles and tendons, peri-articular swelling, induration of the capsule and trophic changes of the skin.

Whether abnormal circulation in the joint is also an etiological factor in the production of bone changes is still a matter of controversy. Wollenberg⁽²⁾ claimed that in osteoarthritis sclerotic changes are found in histological sections of the joints, and he produced overgrowth of the patella in dogs by circular ligation of the soft tissues. This experiment was recently repeated and confirmed by Pemberton⁽³⁾ and his co-workers, who also have shown abnormalities in the blood flow, carbon dioxide content of the blood and in the capillaries of arthritic patients. On the other hand Axhausen⁽⁴⁾ and his co-workers have produced osteoarthritic changes by damage to the cartilage, and this recently was confirmed by Key⁽⁵⁾. The significance of arteriosclerosis in arthritic joints was challenged by Pommer⁽⁶⁾ who found identical changes in normal joints of individuals past middle age. Axhausen and his followers maintain that spur formation and eburnation of the bone are only secondary sequels of the degeneration of the protective, normal cartilage.

In my own studies on the joints of limbs which were amputated on account of arteriosclerotic or diabetic gangrene or Buerger's

disease, pronounced arthritic changes were missing, thus casting doubt on the primary importance of circulatory disturbances in osteoarthritis. No matter whether they are a primary factor in the etiology of arthritis or only a secondary sequel, disturbances of the peripheral circulation are of great importance, and their correction is one of the chief objectives of the therapy of rheumatic conditions.

Heat Therapy

Until recently augmentation of blood supply to the diseased muscle was only possible by indirect methods of production of hyperemia. Heat is one of the oldest and still most commonly employed agents for this purpose. Whether applied in the time-honored, primitive form of hot irons, bricks, packs, baths or in the most modern chemical or physical devices for hyperthermia, the principle is the same. Other means of indirect production of hyperemia are irritants like mustard and capsicum preparations, dry and wet leeches or compression by a tourniquet. Lately a direct attack on the neurovascular apparatus was attempted by ramisection and ganglionectomy chiefly in rheumatoid arthritis. However these extensive operations are indicated only in a minority of severe cases.

Iontophoresis of histamine introduced in 1931, by Deutch⁽⁷⁾ is a simple, harmless but efficient method of dilatation of the minute arterioles and capillaries, accompanied by an increased permeability of the vessel walls. It produces an increase in the blood supply, nutrition and metabolism of the affected tissues. Moreover this method permits an investigation of each factor engaged in the production of the vascular changes and it results in a visible train of reactions which make it possible accurately to control the effectiveness of the treatment.

Pharmacology of Histamine

Histamine or Ergamine acid phosphate is, according to Sollmann,⁽⁸⁾ a product of the cleavage of proteins by acid, ferments or bac-

* Read at the Western Sectional Meeting of the American Congress of Physical Therapy and the Pacific Physical Therapy Association, Los Angeles, June 27, 1935.

* From the Orthopedic Dept., College Medical Evangelists.

teria. It is found in all tissue extracts and is present in large amounts in the normal stool. But as it is rapidly destroyed by bacteria it is not effective when given by mouth. Subcutaneous or intravenous injection of histamine has powerful effects on the circulation and smooth muscles. It constricts bronchioles and the larger arteries and dilates the arterioles and capillaries. Injections of quantities of more than 1 mg. may therefore cause alarming symptoms, consisting of headache, vomiting, a fall in blood pressure, and respiratory disturbances.

A simple experiment demonstrates the powerful influence of histamine on the peripheral circulation. One drop of a 1:1000 solution of histamine is placed on the skin, which is subsequently pricked by a sharp needle. Within five minutes an urticarial wheal surrounded by a red flare will develop. The response of the peripheral circulation consists of a triple reaction: (1) a local dilatation and an increase in the blood flow in the minute vessels (purple spot); (2) a local increase in the permeability of the capillaries, which produces the wheal, and (3) a widespread dilatation of the surrounding arterioles (flare).

The histamine effect on the peripheral circulation is obtained by any method which carries the drug to the minute vessels and capillaries. This can be accomplished indirectly by injection or direct by the local application of histamine solution or ointments. If the direct or local application is used the vessels and capillaries of the corium can be reached by mechanical means, like perforation of the epidermis by needle pricks or scratches. This, however, leaves bruises which prevent frequent reapplication. At present the most effective, suitable method is the application of histamine by iontophoresis.

Technic of Iontophoresis

Any source of a smooth galvanic current can be used. An accurate milliammeter should be available. Histamine like other alkaloids is an anion and carries the electrical charge toward the negative pole. The active (positive) electrode is made either of lead foil covered with moistened gauze, or of any other of the commercial padded electrodes. A 1:1000 solution of histamine is dropped over a piece of blotting paper which corresponds in size to the part to be treated. As

a dispersive negative electrode a large pad over the chest can be used. I found it more convenient, however, to use a nonmetal basin filled with a physiologic salt solution in which an insulated metal plate is placed. One hand is immersed in the solution. The current is slowly increased up to one-half a milliamperere per square inch. It is sufficient to have the current act for 1 to 2 minutes to get the full histamine reaction.

Scratch Method. — In cases in which a galvanic apparatus was not at hand I have used the following method of application of histamine. The skin is cleansed with gasoline; with a sharp-pointed instrument scratches of about $\frac{1}{4}$ inch (0.63 cm.) in length are drawn over the affected area in vertical and horizontal directions. The entire area is thus divided into small squares. A piece of gauze is saturated with the 1:1000 solution of histamine and rubbed into the scratches.

Effects of the Application of Histamine

During the treatment in the majority of cases only a sensation of prickling is felt over the treated part. The current is gradually increased; contact should not be interrupted suddenly.

The exposed skin appears reddened immediately after the removal of the positive electrode. Soon wheals crop up and blend into one patch of urticaria (if cataphoresis was used) or into stripes of urticaria (if the scratch method was used). The temperature over the treated parts rises from 2 to 3 degrees C. (3.6 to 5.4 F.). Gradually the elevation of the skin recedes, leaving red spots. The skin returns to its normal appearance in from five to six hours.

Bettmann⁽⁹⁾ studied the capillary changes and found a marked increase in the rate of circulation, in the number of capillaries visualized and dilatation of the subpapillary vessels. He demonstrated experimentally the marked influence of cataphoresis of a 10 per cent solution of sodium iodide preceded by an application of histamine, on the resorption of the skin of rabbits. Controls treated with iodine by cataphoresis only showed, in the section, particles of iodine precipitated with thallium acetate in the superficial layers of the corium, while the sections of the skin which were subject to preceding histamine

cataphoresis showed iodine particles scattered through all the layers.

The similarity in the reactions and therapeutic results of the iontophoresis as well as the mechanical (scratch) method is conclusive evidence that the galvanic current has no other action than to convey the histamine to the capillaries and arterioles in the corium. It is, however, the most satisfactory carrier yet employed for this purpose. The controversial question, how deep drugs can be carried into tissues does not enter in the application of histamine.

Results of Histamine Therapy

Deutsch in 1931, reported favorable results by iontophoresis of histamine in 250 cases of rheumatic affections. A number of European investigators have since confirmed his findings. Only two authors denied the efficiency of this treatment. I have used this method since 1932, and have presented the results before the New York Physical Therapy Society in February, 1933, and in two publications^{(10), (11)}.

A tabulation of the available material in 1933 has shown that out of 730 cases reported, 610 patients or 83.5 per cent were cured or improved, 120 or 16.5 per cent were not benefited. Relief was temporary in 85 or 24.8 per cent of these cases. In my own material of 68 cases, 49 or 72.1 per cent were cured or improved, 19 or 27.9 per cent did not show any improvement. The percentage of recurrences in myositis in my material was only 3.2 per cent. Lately interest in histamine iontophoresis is manifested by articles that have appeared in England and in the United States.

Severne Mackenna⁽¹²⁾ confirmed the favorable result in rheumatic conditions. Joseph C. Doane⁽¹³⁾ reported good results in five cases of myospastic and vasospastic conditions of the extremities, and several cases of hypotrophic arthritis.

In Table 1 are presented the results in 150 cases of rheumatic affections and disturbances of the peripheral circulation. One hundred twelve or 74.6 per cent were improved or cured, 38 or 25.4 per cent were not benefited.

Myositis. — Painful contractions chiefly involving the neck, shoulder, loin, and thigh muscles, constituted in the previous reports 52 per cent of the total material. In 91.2 per

cent, cures were reported. This prevalence of myositis was due to the relatively short time since the introduction of histamine which permitted to draw definite conclusions only in relatively acute conditions.

The present material lists 47 cases of myositis, or 31.3 per cent of the total. Thirty-eight cases or 80.1 per cent were cured, and 9 or 19.2 per cent were not cured. In these cases of uncomplicated myositis complete recovery, with applications not exceeding twelve in number were included in the favorable results. The average number of treatments was six.

The ages of the patients ranged between 19 and 67 years, the duration of the symptoms from one week to two years. The diagnosis was based upon pain, tenderness and limita-

TABLE 1. — *Results in 150 Cases of Histamine Iontophoresis*

Condition	No. of Cases	Cured or Imp.	Per Cent	Not Imp.	Per Cent
Myositis	47	38	80.8	9	19.2
Subacromial Bursitis..	10	10			
Tenosynovitis	4	4			
Vasospastic					
Conditions	6	4	66.4	2	33.6
Buerger's Disease ...	2	1		1	
Brachial Neuritis ...	8	7	87.4	1	13.6
Osteoarthritis	25	15	60	10	40
Infectious Arthritis..	13	10	76.2	3	23.8
Rheumatoid Arthritis	8	7	87.4	1	13.6
Post-traumatic					
Arthritis	7	7			
Sacroiliac Arthritis..	8	2	25	6	75
Spondylarthritis and Radiculitis	12	7	58.4	5	40.6
Total	150	112	74.6	38	25.4

tion of motion due to the contraction of muscles. Sometimes distinct hard nodules, known in the German literature as myogelosis, were palpated in the insertion of the muscles. On the other hand no involvement of the bones or joints was found clinically or radiographically. From what has been said it is evident that thorough examination of all of the muscles of the affected parts for pain, tenderness, contraction and nodules is of utmost importance for success with the treatment.

The effect of the treatment in favorable cases is rather striking. Immediately after the first application, pain and tenderness disappear, and motion is increased. If the initial effect is not pronounced, the final outcome is doubtful. This analgesic effect lasts at first

for several hours, corresponding to the aforementioned changes in the circulation. The treatment is therefore at first repeated daily. As improvement is noted, the painless intervals increase from twenty-four to forty-eight hours. Treatment is then given every second or third day, until all symptoms have disappeared.

Subacromial Bursitis and Tenosynovitis — In ten cases of subacromial bursitis of one week to two years' duration, the symptoms disappeared after six to fifteen applications. In five of these cases, radiograms showed deposits of calcium; four cases had been previously treated without success by diathermy.

In four cases of stenosing tenosynovitis of the extensor tendons of the thumb, treatment was successful after four to twelve applications. Duration of the symptoms was between one to six months. Two of these cases received previous diathermy and shortwave without relief. Histamine iontophoresis seems to be the most efficient procedure in subacromial bursitis and tenosynovitis.

Vasospastic Conditions. — Of the six cases under this heading, one is a case of Raynaud's disease, one of angioneurotic edema, and four of acroparesthesia of the fingers and toes. In four cases improvement followed two to twenty applications. In two cases treatment was not successful. In acroparesthesia, especially of women past middle age, histamine cataphoresis is of distinct value. Vas had good results in eighteen out of twenty cases. Of two cases of Buerger's disease improvement was seen in one.

Brachial Neuritis. — Seven out of eight cases showed definite improvement. However, twelve to twenty-five applications were necessary, and relapses were frequent. In this condition the treatment is to be regarded only as an adjuvant to the elimination of causative factors.

Arthritis

Seventy-three cases were treated, 61 involving the peripheral joints and 12 the spine. The latter showed symptoms of radiculitis. We divided the material into the following types:

(1) *Post Traumatic Arthritis*. — Seven cases were treated with uniformly good results after six to twelve applications. Injury in these cases took place six months to two years previous to treatment.

(2) *Infectious Arthritis*. — Thirteen cases of subacute and chronic polyarthritis of infectious origin, including three cases of gonococcal arthritis were treated. Duration of the symptoms was from one to fifteen years. The x-rays showed relatively slight changes in the articular surfaces. Soft tissue swelling, effusions, contraction of muscles were predominant. Ten cases or 72.6 per cent, were improved, three cases or 23.8 per cent, were not improved. The three cases of subacute gonococcal arthritis were benefited. The treatment was more effective in the small joints of the hands and feet than in the large joints.

(3) *Rheumatoid Arthritis*. — Eight cases of two to twenty years duration were treated. Involvement was bilateral, especially in the wrists, fingers, and toes. Deformities, contractures, and atrophy of muscles, periarticular swelling and trophic disturbances of the skin were common besides fibrous ankylosis in some of the joints. The treatment was confined to painful joints which were not completely ankylosed. In seven or 87.4 per cent, improvement was seen by decrease of swelling, pain, contractures, and increase in the range of motion. The results were especially favorable in this group of smaller joints. The number of treatments was from ten to thirty. The treatments had to be repeated in some cases on account of recurrence.

(4) *Osteoarthritis*. — Twenty-five cases involving chiefly the knee joints and end-phalangeal joints in middle age patients are listed under this heading. Duration of symptoms was from six weeks to seven years. The x-rays showed pronounced spur formation and eburnation of the articular surfaces. In a number of cases the soft tissues were swollen and effusions were present. Fifteen cases (60 per cent) showed improvement in pain and stiffness after six to twenty-three applications. In ten cases no improvement was seen.

(5) *Sacroiliac Arthritis*. — Eight cases were treated, two or 25 per cent, of which were improved. Six or 75 per cent were not improved. The results in sacroiliac arthritis were the least favorable of any of the joints treated. This may be partly due to the distance of the joints from the surface of the body.

(6) *Spondylarthritis and Radiculitis*. — Of twelve cases, seven or 58.4 per cent were

improved. Five or 40.7 per cent, were not improved. Arthritis of the cervical spine predominated and was usually connected with radicular symptoms. Duration of symptoms was from three weeks to ten years. The number of treatments ranged from twelve to thirty.

Discussion

Iontophoresis of histamine is established as an efficient treatment of disturbances of peripheral circulation and rheumatic affections of the soft tissues, like bursae, tendon sheaths and muscles. It seems to surpass other procedures.

In the various forms of arthritis it can be used to good advantage against the deficiency of blood circulation and the resulting involvement of soft tissues, contracture of muscles, swellings, and infiltration of the capsule and periarticular tissues. The alleviation of pain and spasm are often instrumental in restoring function in diseased joints. No such beneficial results can be expected where bony changes and fibrosis exist. Accordingly the best results are seen in post-traumatic arthritis, and in cases of infectious and rheumatoid arthritis which did not as yet progress to ankylosis and destruction of the joints. The results in arthritis compare favorably with other therapeutic methods. Histamine iontophoresis is simple and harmless, and can be readily combined with other types of treatments. The results have stood the five year trial period. Only Kauffmann and Ruhmann denied the beneficial effects of the treatment.

Kauffmann⁽¹⁴⁾ maintained that the analgesic effect is due to the action of the positive pole and not of the histamine. This can be easily disproved as the application of histamine by the scratch method or injection was identical in effect. Ruhmann⁽¹⁵⁾ only conceives a counterirritating effect, like that of capsicum.

This analogy is only superficial. The diffuse irritation of the skin resulting from a plaster of capsicum and which prevents repeated application, is not produced by histamine, which has a selective action on the blood vessels. The skin returns to normal after several hours, and the histamine can be reapplied immediately. Both authors used a faulty technic. They applied the histamine only on painful spots and did not treat the antagonists as well.

Recent Modification and Substitutions

The vasodilatation produced by histamine iontophoresis lasts from three to four hours. In order to reinforce the effect of the treatment, especially in chronic arthritis, I have shortened the intervals by applying the treatment three to four times daily. This method of application, however, requires hospitalization. I have therefore tried to produce the histamine effect by massaging various histamine ointments or vigorous friction after heating of the part. To date the reaction was not entirely satisfactory. It is however possible to give the patient instruction in galvanic iontophoresis for home treatment.

In order to reinforce the action of histamine, especially in osteoarthritis, I have combined iontophoresis of histamine with iodides, salicylates, and other agents. The number of cases is too small to justify a report of the results at this time.

Shanson and Eastwood⁽¹⁶⁾ have given subcutaneous injections of 0.1 to 0.5 mg. of histamine two to three times weekly and had good results, especially in rheumatoid arthritis. I am opposed to this route for the reason that undesirable systemic reactions predominate while vasodilatation over the joints is inadequate.

The strongest histamine reactions occur in the upper part of the body. The head is deeply flushed. Erythema covers the shoulders and upper chest. A fall in blood pressure, dizziness, and vomiting are frequent. The temperature however, of the peripheral joints where vasodilatation is needed is only slightly elevated.

As a substitute for histamine Kovács and Kovács⁽¹⁷⁾ have introduced mecholyl, a cholin derivative, which is supposed to dilate chiefly the arterioles. It is applied in a 1 per cent solution by iontophoresis, identically as with histamine. The intensity of current is far stronger, up to thirty milliamperes, and the duration of treatment is far longer, up to twenty to thirty minutes.

The authors state that pronounced systemic effects like sweating, increased salivation, pulse rate, and intestinal peristalsis occur. Locally, sweating, "goose flesh," but only slight redness is seen. The temperature is increased from two to eight degrees F. Like in histamine the best results of mecholyl iontophoresis are claimed in rheumatoid arthritis and vasospastic conditions. I have investigated

the comparative effect of histamine and mecholyl on the peripheral circulation. A drop of 1 per cent mecholyl applied on the skin and introduced by needle pricks into the corium produces a wheal which is smaller, and a flare which is fainter than with a 1/10 per cent solution of histamine. As the flare is an indication of the dilatation of the arterioles, it indicates that the action of 1 per cent mecholyl is not only weaker than the action of 1/10 per cent of histamine on the capillaries but on the arterioles as well.

Introduced under a diseased part by iontophoresis, the reaction of 1 per cent mecholyl was decidedly inferior to the 1/10 per cent of histamine. In the latter, within five minutes the wheals had formed a prominent patch of urticaria. The flare surrounding them was deep red. With mecholyl, after fifteen minutes, with several times the amount of current necessary for the histamine reaction, the urticaria was less pronounced and the flare was smaller and pinkish. The temperature increase was markedly less than over the skin treated with histamine.

The reaction Kovács called "goose flesh," is nothing characteristic for mecholyl, but merely a wheal formation which is seen in a higher degree with histamine.

The authors were in error when they claimed that no systemic reaction occurs with histamine iontophoresis. If the treatment is prolonged to ten and twenty minutes, and an intensity of current is used which they apply with mecholyl, the same general systemic reaction takes place. It is the great advantage of histamine that the desired peripheral vasodilatation over the diseased part is effected within five minutes, and with such a weak current that undesired and dangerous systemic reactions are avoided. For these reasons I believe mecholyl to be an inferior substitute for histamine iontophoresis.

Case Histories

The following cases are selected to represent the results of each of the groups given in Table 1.

CASE 1.—Mrs. O.; age 50, housewife.

Chief complaint.—For two weeks pain and limitation of motion over right shoulder.

Examination.—Elevation of shoulder limited to 90 degrees abduction. Passive motion in all directions normal. Definite contraction, tenderness, and pain over right trapezius.

Diagnosis.—Myositis of trapezius.

Treatment.—Three histamine applications covering trapezius, brachialis, and deltoid muscles. Full recovery.

CASE 2.—I. S.; age 55.

Chief complaint.—For past six months pain in right wrist. Received heat applications which were of no help. General condition satisfactory. No rheumatic affection with the exception of pain and tenderness over long extensor tendon of right thumb. Twisting of the hand in the ulnar direction increases pain.

Diagnosis.—Stenosing teno-synovitis of long extensor tendon of right thumb.

Treatment.—Six diathermy followed by six short wave treatments were given without producing improvement. Promptly relieved by six applications of histamine over right wrist. Has remained free of symptoms over one year.

CASE 3.—Mrs. G. W.; age 45, housewife.

History and chief complaint.—1913—muscular and inflammatory rheumatism; 1920—goitre removed; 1923—ulcers of the stomach. Pain, numbness, cold, and cyanotic hands. Chronic constipation and vaginal discharge.

Examination.—Height 4' 11", weight 120 pounds. Scoliosis of spine. Puffy eyelids. Seborrhea. Increased fat pad over right knee joint. Transitory effusion of right knee joint during treatment. Kyphosis of dorsal spine. Blood pressure 98/68. Vaso-circulatory disturbances of feet and hands.

Diagnosis.—Vaso-circulatory deficiency of hands and feet.

Treatment.—Twelve histamine applications combined later with short wave vaccine, and thyroid injections. Temporary improvement only.

CASE 4.—C. A.; age 65, physician.

Chief complaint.—Attacks of pain in right arm of eighteen years duration of frequent occurrence radiating to finger tips. Suffers from asthma and frequent nosebleeds. Sensitivity and tenderness over right shoulder muscles, especially over deltoid biceps, and brachialis. Motion normal, but there is atrophy of muscles.

Diagnosis.—Brachial neuritis.

Treatment.—Twelve applications of histamine, 10 milliamperes for five minutes. Immediate relief of pain. Progressive gradual improvement during past two years.

CASE 5.—Mrs. H.; age 38, technician.

Chief complaint.—Pain and grating of left knee joint for two years. Patient has menorrhagia due to fibroids.

Examination.—Weight 165; height 5'; rough skin, scanty hair on eyebrows, seborrhea; thickening of soft tissues over left knee joint and tenderness of inner aspect of knee joint. X-ray shows spore formation at the articular surface of patella and tibia.

Diagnosis.—Osteoarthritis of left knee joint.

Treatment.—Ten histamine applications. Decreased pain and swelling. Full range of motion. Grating on motion unchanged. Now continues with thyroid.

CASE 6.—Mr. W. R.; age 40, architect.

Chief complaint.—For fifteen years following a

middle ear infection and mastoid operation, developed pain, swelling, and stiffness of spine and numerous joints. Beside medical treatment he was put in a plaster-of-Paris jacket for three months, after which the spine became ankylosed in a straight position. Left knee joint is fibrous ankylosed. Pain in hands and feet.

Examination.—General condition good. Patient uses wheel chair, and active locomotion is possible only by swinging body from shoulders on crutches. X-ray shows a complete bony ankylosis of lumbar and dorsal vertebrae and sacro-iliac joint. Contractions of flexor tendons in both feet. Deformity of both hands. Flexion and ulnar deviation of both fingers and hands. Right wrist joint shows periarticular swelling. Marked tenderness and pain which prevents use of hands. This is a very serious setback because the patient, being an architect, finds drawing his only diversion now.

Diagnosis.—Infectious polyarthritis with ankylosis of spine and knees. Advanced periarticular swelling of right wrist joint.

Treatment.—Fifteen histamine applications over wrist joint. Pain ceased. Motion increased and patient able to resume drawing.

CASE 7.—Mrs. R. B.; age 50, housewife.

Chief complaint.—Suffering for last year and a half with swelling, stiffness, and pain of hands, feet, and ankles. Has been rendered an invalid. Four months ago tonsils and two abscessed teeth were removed; condition became worse.

Examination.—Patient nervous and run down. Soft tissue swelling in left knee. 30 c.c. of turbid fluid was aspirated. Periarticular swelling of both wrists and cyanosis of the hands.

Diagnosis.—Infectious polyarthritis.

Treatment.—Given fourteen histamine applications to knees, wrists, and ankles in addition to vaccine. Immediate relief of pain and increased motion after application. Progressive improvement. No recurrence of effusion, and recession of periarticular swelling.

CASE 8.—Mrs. F. H. age 54.

Chief complaint.—For five years pain and swelling starting in left knee and involving later the right knee, both wrists, fingers, and feet. Condition advanced until patient was entirely crippled and permanently bedridden.

Examination.—Patient emaciated; periarticular swelling of both wrists. Deformity of finger joints with ulnar deviation. Deficient circulation in both hands and feet. Periarticular swelling and contraction of both knees, which show only 10-15 degrees of motion.

Diagnosis.—Rheumatoid arthritis.

Treatment.—Patient received thirteen histamine applications over wrists and knees, in addition to vaccine. Condition remained unimproved.

CASE 9.—Mrs. E. H.; age 65, housewife.

Weight 95 lbs., height 5' 1". Came to office March 12, 1935.

Chief complaint.—Painful hard nodules over flexor tendons of the fingers of both hands. She has received injections and medication which gave no relief and had to be discontinued because of gastric disturbances.

History.—Rheumatic fever at age of seven. Subsequent attacks became rarer with menopause. Attacks involved numerous joints.

Operations.—1907, rectal abscess and mucus colitis; 1910, cholecystectomy; 1912, appendectomy.

Teeth. Numerous devitalized and abscessed teeth were removed. Patient is frail, has marked kyphosis, insufficiency and stenosis of mitral valve. Hard nodules at base of metapalangeal joints of both thumbs and index fingers. A hard right cubital gland is present.

Diagnosis.—Polyarthritis with rheumatic nodules following recurrent rheumatic fever.

Treatment.—Histamine and 2 per cent solution of quinine applied from positive pole over dorsal and palmar aspects of both hands for five minutes. Marked relief of pain after first treatment. Has received a total of three treatments. Nodules diminished and pain has ceased.

CASE 10.—Mr. F.; age 36, dancer.

Chief complaint.—For last six months weakness of left knee joint with tightening of muscles. Sharp pain especially on turning. This disables patient.

Examination.—Enlarged fat pads on both knees. Grating in left knee upon motion. Irregularity of inner condyle of left tibia. X-ray showed a periostitis at head of fibula corresponding to insertion of outer collateral ligament. Rough grating of muscles upon motion of thigh. Insertion of adductor and quadriceps muscles tender.

Diagnosis.—Traumatic arthritis of knee and myositis of thigh muscles due to occupational injury.

Treatment.—Received fifteen histamine applications later combined with short wave. Immediate relief of pain. After six treatments was able to resume dancing and did not have any recurrence in past year.

CASE 11.—Mr. J.; age 38.

Chief complaint.—Deep pain on sudden motion in region of sacrum and lumbar spine. Various types of treatment with no marked shortening of intervals of attacks of pain.

Examination.—General condition good. Left sacro-iliac joint and junction between sacral and lumbar vertebrae tender. X-ray shows irregularity and slight spur formation over left sacroiliac joint.

Diagnosis.—Sacroiliac and lumbosacral arthritis.

Treatment.—Twenty-three histamine applications over sacro-iliac and lumbo-sacral junction. Temporary improvement only.

CASE 12.—Mrs. E. S.; age 60, housewife.

Chief complaint.—Attacks of pain in left arm radiating to fingers and of pain in thigh radiating down legs, for last ten years. Numerous abscessed teeth removed with no evident improvement. Gall bladder disease diagnosed two years ago. After walking several blocks has severe cramps in left calf.

Examination.—Poor general condition. Marked kyphosis of dorsal spine and tenderness between 7th and 6th vertebrae. Hyperlordosis of lumbar vertebrae. Heberden nodes at second phalangeal joints of fingers. Depressed longitudinal arches.

X-ray shows bridging between dorsal and lumbar vertebrae.

Diagnosis.—Osteoarthritis of spine with radiculitis and deficiency of peripheral circulation.

Treatment.—Fifteen histamine applications in addition to posture exercises. Immediate relief with gradual permanent improvement during past two years.

CASE 13.—Mrs. C. B.; age 44, housewife.

Chief complaint.—Attacks of "lumbago" for fifteen years, of sudden onset and one-two weeks duration. Prevents her from straightening her back. The attacks have increased in intensity within the past several years, and the free intervals are shortened. Pain in right elbow and shoulder for last year.

Examination.—Marked scoliosis with convexity to right of sacral and lumbar vertebrae. Contraction of erector spinae muscles. Pain and tenderness over right shoulder. Cyanotic hands and feet. Blood pressure 110/70.

Diagnosis.—Radiculitis and myositis of right shoulder and lumbar muscles and peripheral vasospasms.

Treatment.—Ten histamine applications to shoulder and lumbar regions. Immediate relief from pain. Improvement for five months after which a recurrence was checked with two further treatments.

Summary

One hundred fifty cases of histamine iontophoresis in rheumatic affections and disturbances of peripheral circulation are presented.

1. In the affections of the soft tissues, muscles, bursae, and tendons, 80 to 100 per cent of cures or improvements were noted.

2. In vasospastic conditions (Raynaud's disease, acroparesthesia, angioneurotic edema) the percentage of improvement amounted to 66 per cent. Also in one case of Buerger's disease improvement was seen.

3. In brachial neuritis improvement occurred in 87 per cent.

4. Of the cases of arthritis treated, 100 per cent improvement occurred in the post-traumatic type. In infectious and rheumatoid arthritis 76 per cent of the patients were improved. This, however, applies only to the smaller joints of the hands and the feet in cases where destruction did not proceed to fibrosis or ankylosis. In osteoarthritis of the knees and in spinal arthritis with radiculitis about 60 per cent showed improvement. Least successful was the treatment of sacroiliac arthritis with only 25 per cent improvement.

5. Iontophoresis of histamine is superior to substitutes like massaging of histamine

ointments, subcutaneous injections, and mecholyl iontophoresis. The strongest local vasodilatation is achieved in the shortest time of application, with the weakest intensity of current, thus safeguarding against dangerous and undesirable systemic reactions.

6. Intensification of treatment by two and three daily applications in severe cases, and combination of iontophoresis with other substances is advocated and studied.

1930 Wilshire Blvd.

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NEWER TECHNIC OF COLON THERAPY *

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Colon therapy is today regarded as the most abused and also the most neglected method in physical medicine. Until recently it has received from the regular profession lukewarm approval, downright disapproval, or ridicule. As an example of ridicule one may recall the witticism by a member of our profession about a certain technician who was not interested in diathermy or other electrical modalities, "but had put her soul into an enema." This variety of forced humor is devoid of point or logic. The technician is to be praised for having put her soul into whatever she was doing. What wonder, then, that under such immature conceptions by our own colleagues, quacks are still reaping a rich harvest from two classes of patients: those who are too ignorant to hesitate in the face of extravagant promises; and those who are too intelligent to be deprived of a remedy they have tested in spite of its hasty rejection by their physicians. Local hydrotherapy of the colon is the latest method of physical medicine to be rescued from pretenders in the healing art.

There can be no question that we often are confronted by conditions involving the colon which, to use a simile, require the Herculean task of cleaning out the Augean Stables. While Hercules solved his problem by diverting two river channels through the stables, our task is not so easily disposed of. When dealing with atony of the colon, irrigation is by no means easily accomplished. From this it can be seen that any device or method that facilitates thorough cleansing of the large bowel under physiologic conditions, merits our most serious consideration.

We are in a position to report on such an apparatus, devised by an engineer familiar with the problems of hydro-physiology—Hugh E. Dierker—two of which have been extensively in use at the Hollywood Hospital. The apparatus has a reversible pressure for inflow and outflow. Positive pressure of one-quarter to one-half a pound forces fluid into

the bowel, filling it gently. Reversal of levers enables the fluid to flow out under the stimulus of normal muscular contraction of the colon.

If the bowel is too atonic to contract, gentle negative pressure (suction) can be induced to cause progressive contraction of the colon, beginning at the rectum and reaching as far as the column of water has advanced under positive pressure. If the entering column of water is arrested at a fecal impaction, it gradually draws off fragments when the pressure is on the reverse, and tends to loosen the mass from the mucous membrane so that continued injections under positive pressure may work around and undermine it, and by alternating with the negative pressure (suction) produce still further disintegration.

As this apparatus has been described in detail by Hibben,⁽¹⁾ and Worster⁽²⁾ we will limit ourselves to a few illustrative cases, with brief comments on the indication for colon therapy. In this regard it should first be pointed out that the Dierker apparatus facilitates recognition of the condition of the colon.

This is demonstrated by watching the movement of the mercury column in the manometer, similar to that in the blood-pressure set, indicating the condition of the musculature of the bowel, whether it is normal, atonic or hypertonic. Added to this is the visual inspection of the return flow, through the glass portion of the outflow tube, which informs us of the character and amount of the stool, mucus, gas, undigested food, or foreign bodies, like psyllium seeds or bran.

All cases entering Hollywood Hospital carry an admitting diagnosis. If this is "obstinate constipation" or "fecal impaction" or "partial obstruction of the bowel," colon therapy is prescribed. But when the diagnosis does not give so ready a clue, the attending physician's resourcefulness, or his indulgence of suggestions from the physical therapy department, develops some dramatic histories. A few examples follow:

* Read at the Western Sectional meeting of the American Congress of Physical Therapy and the Pacific Therapy Association, Los Angeles, June 27, 1935.



Fig. 1.—A new apparatus (Dierker) for colon irrigation which also permits drainage and lavage of other cavities.

Case Histories

CASE 1.—A woman, age 37, motion picture actress. Admitting diagnosis: acute subachromial bursitis of the right shoulder. Suffered intense pain for past 24 hours. Hypnotics and opiates gave no relief, but only made her irrational. Radiathermy and heat in other forms did not help. Nausea and vomiting set in, which the patient declared was due to the morphin. The vomiting became persistent and the facies became suggestive of intestinal obstruction.

On admission, the patient had reported inadequate bowel movements for several days, and her physician ordered a colon irrigation. This delivered a three days' retention stool. The next day there was no movement of the bowel. On the third day another irrigation was given and nothing was secured but scybala of the form of the haustra.

The fact that there was no liquefied stool proved that the irrigation had not reached the cecum, and that we had to deal with a fecal impaction. During the night, the patient had a few small diarrheal stools. In the morning she begged for another irrigation. This was given and more hard fecal masses came away. Then, suddenly, under the negative pressure (suction) the impaction broke down and with the fecal fragments and fluid stool there came a handful of psyllium seeds taken two weeks previously. The psyllium seeds were the nucleus of the impaction.

An interesting feature was that the patient's shoulder was immediately relieved, and she has had

no trouble with it since. She is continuing a course of colon treatments.

CASE 2.—A man, age 78, retired. Admitting diagnosis: possible obstruction of the bowel. A gastrointestinal series, and a barium enema had been given in the x-ray department, but he had not cleared the barium from the bowel. He had been complaining for five weeks of slight, vague abdominal pain, worse at night and causing nausea and vomiting. He had lost 19 pounds during this time. After the lower bowel was cleared, proctoscopy revealed a papilloma about $1\frac{1}{2}$ cm. in diameter, acting as a check at the rectosigmoid juncture, the sphincter of O'Beirne. After three colonic irrigations by our technic, x-ray examination showed a clear colon. The proctologist coagulated the papilloma. There was no pain during the operation, not even a local anesthetic being necessary. The patient has had no further trouble.

CASE 3.—A woman, age 42, housewife, Italian, obese and pale, with staring eyes; abdomen large and distended. Admitting diagnosis: hemorrhoids and rectal fissure. Had been in bed for several months. Her tenth baby was born four months ago. Since then there has been inability to move the bowel adequately "on account of the hemorrhoids," she said. Has been taking enemas of soap-suds and soda, the return being very dark water, but no formed stool. Every time she went to stool, "something came down and stopped it," and then this "something" would go back into the rectum. In three consecutive irrigations given to this pa-

tient in three days, a total of about three quarts of fecal material was secured. At this time, the impaction having been cleared, she was operated for hemorrhoids and fissure. The interesting feature was that a papilloma, similar to that in the previous case, but lower in the rectum and with a longer pedicle, was found and removed. This was the "something" that came down and went back. The patient subsequently had adequate bowel movements.

CASE 4. — A man, age 60, in active business. Admitting diagnosis: diarrhea. History of seven or eight stools daily for two or three months. Has lost considerable weight and has been troubled with dizziness. The first colon irrigation removed many hard scybala, from the size of a pea to that of a hazelnut. The diarrhea stopped after the first treatment, although not all the hard material was removed until the second irrigation. This patient had a total of five treatments and on only one occasion was there a recurrence of diarrhea, when he had failed to keep an appointment for treatment and had become constipated. He later went to Arrowhead Springs for a much needed vacation, where he could continue the colon therapy.

As alternate diarrhea and constipation may mean a fecal impaction, the colon should be thoroughly investigated before "diarrhea" is accepted as anything but nature's abortive effort to wash out the hard masses that are irritating it.

CASE 5. — A woman, age 58, housewife. Admitting diagnosis: high blood pressure and mental deterioration, suggesting senile dementia. Babbles irrationally about her bowels and declares that she cannot get a movement even when she takes epsom salts, and what little comes as a result of the salts "burns like fire." This patient required high sideboards on her hospital bed to keep her in, as she was constantly trying to get to the toilet. She was given an intensive series of colon irrigations, two or three in one day. The first one or two brought only hard scybala and a small quantity of offensive fluid. Then bran began to come away with the irrigation, literally by the cupful, mixed with very foul feces. A total of ten cups of bran was delivered before we obtained a return without any bran. Even then, the last return was foamy, disclosing fermentation caused by reversed peristalsis into the ileum. The bran had been taken weeks before and forgotten. The patient cleared up mentally and went home to enjoy about three years of life before her death by apoplexy.

CASE 6. — A woman, age 46, motion picture actress. Admitting diagnosis: cholecystitis and intestinal adhesions. Complains of pain and sensation of a mass in the region of the splenic flexure. A course of irrigations during a period of about a month brought away a total of several quarts of membranous mucus. At first the mucus was the color, size and conformation of a stool, showing the rugae and diverticula. In the fifth irrigation, psyllium seeds began to come away and continued through five more treatments. The psyllium seeds had been ingested five weeks previously.

After 14 irrigations, the mucus having markedly diminished in quantity and consistency, the patient was subjected to laparotomy. Bands of adhesions

were found as wide and as thick as the ileum, constricting the colon and preventing normal peristalsis. The appendix, retrocecal and buried in adhesions, was removed, all contracting bands were ligated and severed. The patient made an uneventful recovery largely attributable to pre-operative preparation by the intensive course of colonic therapy.

Medicaments

Unmedicated water should be used at first, as medication is not needed until the rectum is empty. When the type of colon under treatment has been determined, the choice of solution may be made.

The blandest solution is one of a milk product of condensed whey, lactic acid, mineral salts, and some albumin. This is soothing to a mucous membrane that has been irritated by the alkaline products of putrefaction. It seems to loosen the mucus.

For atonic colons, sulphur solution is effective. There are liquid sulphur preparations, some purely synthetic, one a derivative of Paso Robles sulphur spring water.

When ulceration is suspected, the whey solution is soothing. A combination of witch hazel and glycerine (8 ozs. of witch hazel, 4 ozs. of glycerine to the 4-gallon tank), is also healing to congested or ulcerated surfaces.

Tap water is sufficient in many cases if its pH is nearly neutral. It is the proper medium to use in preparing for an acidophilus implant, except that the whey is not incompatible with acidophilus and may be used to cleanse the colon before the implant, in cases where intensive help is needed, as in the pre-operative period.

There is available a rich growth of acidophilus on the medium of the juice of the soy bean that is well received by chronic colitis patients. It may be used as an implant either in a small retention enema, or more diluted in the last two gallons. The same soy-acidophilus may be taken by mouth to advantage in conjunction with colon treatments and implants, a tablespoon night and morning for two or three months.

It is advisable to use as a lubricant for the applicator tube some salve that experience has shown to be healing for fissures or piles. Calendula cerate, made from the garden marigold, a cousin to the arnica, is excellent. One of the sunburn remedies, such as antipyraxol, is agreeable to the patient, being both antiseptic and analgesic.

Indications

These include practically all chronic conditions, because they are usually due to two or more foci; and no focus is more common, or more apt to be overlooked, than the colon.

The application of colon therapy to fever treatment should be emphasized. It is bad practice to induce fever without first emptying the colon of absorbable material. One should not boil a cesspool *in vivo*. Acute alcoholics, if given the pyrexia bath without preliminary colon clearing, are apt to suffer nausea and syncope, but take the bath well if cleared first of colonic contents.

In addition there are three minor indications for colon therapy that are frequently encountered and passed unnoticed. One is the appearance on the chest, abdomen and back of bright red telangiectatic spots, often called by the laity "blood moles," or, if irregular in outline, "spider cancers." These little hemangiomas are tiny danger flags, signifying intestinal toxemia.

Another indication is a mental symptom, very commonly met with and dismissed with the lazy diagnosis of "hypochondria" or "neurosis." These are the introspective patients who study their symptoms and make their own diagnoses completely at variance

with the facts, but suggested to them by an item in the newspaper or by the last letter from a friend who writes that her sister, or her husband, is very low with cancer, diabetes, or tuberculosis. The patients run to the doctor in the belief that they themselves have one of these horrible diseases. In such cases bear in mind that "colon irrigation washes away worry."

A third minor condition that may be ameliorated by colon therapy is the hot flashes of the climacteric. One of our patients who is subject to a number of hot flashes and sweats during the night, subsequent to intra-uterine radium therapy, reports that she has a restful sleep following a colon treatment by the newer technic.

The French have a saying, if there is mischief, search the woman, — *cherchez la femme*. We may paraphrase this by saying, — if there is illness, *search the colon!*

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SHORT RADIO WAVES AND FEVER THERAPY *

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AND

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Recently Gale⁽¹⁾ reported results of experiments on the selectivity of heating effects by hertzian waves in water and dilute solutions. He concludes that short waves and ultrashort waves have the power of selective heat penetration and that the resulting death of unicellular organisms in water is brought about solely by the heat-effect. Our interest in this problem leads us to contribute some data and to present our viewpoint.

Hosmer's⁽²⁾ work in our Schenectady laboratory, in 1928, led us to a conclusion sim-

ilar to the one reached by Gale. While pure, distilled water heats but very slightly, tap water, and dilute solutions corresponding to the blood are readily heated by a wide range of high frequencies. The lethal action on organisms in the water and the death of animals whose blood was thus heated we also attributed to the heat-effect alone. In some cases a host can withstand temperatures which an infection may not tolerate. This opens a field of study which is now being intensively pursued in this country and abroad. Hosmer's⁽²⁾ findings seemed to connect the heating directly to the electrolytic ions of the dissociated salts

* From the Research Laboratory, General Electric Company, Schenectady, N. Y.

of the solutions. Thus the heating rate of solutions of widely different salts under the same conditions was always identical when the electrical resistances were made the same by suitable selection of the concentrations.

Hosmer⁽²⁾ also showed that for any wavelength there is a certain concentration or resistance which gives maximum heating effect. This heating maximum shifts towards the more concentrated solutions as the wavelength is decreased. De Walt⁽³⁾ has published curves showing this connection between concentration or resistance and frequency. McLennan and Burton⁽⁴⁾ have given the derivation of such formulae as express the relations of interest.

It is our aim to make clearer some of the researches in this field which we feel will certainly have to be made, and to contribute a mechanical concept of the related phenomena. We are especially interested in the problem because, while we assume that the lethal effect on disease germs in tissues is due to heat alone, we are not certain but that there will be found, under some conditions of wavelength and infection-environment, some wavelength with specifically germicidal power. After such a discovery, some explanation in accord with fundamental knowledge could probably be provided.

Gale's experiments, in which various containers of 3 per cent permanganate solution were surrounded by tap water in a vessel which in turn was subjected to the electrostatic hertzian field, showed that the heating occurred more rapidly in the permanganate solution than in the tap water, and was most rapid in the container of greatest diameter. This is a general result, and one may regard it as illustrative of the antenna principle in radio; that is, each part of the solution in the direction from plate to plate acts as antenna for all the other parts. Thus, for any single part it is much as though one brought the condenser plates near to that part. If the containers instead of being circular (a beaker) are cylindrical (a tube), the heating is greatest when the cylinder is subtending the greatest possible part of the condenser gap. In a circular container the heating under some conditions may be greatest along the diameter in the direction towards the plates. In other words, the heating may be non-uniform.

Relation of Frequency to Heating

While various workers have provided mathematical formulations showing the relation between frequency, electrical resistance, dielectric capacity, shape factor, etc., of such circuits, we have temporarily made use of simple pictures which are of aid to our purpose. They help answer our question of how the heating can depend on the ions in the solution, have maxima varying with concentration, with shape and orientation in space, and yet always increase in heating with rise of frequency. In our picture we confine ourselves first to aqueous solutions, because these are common in nature.

At first approach, we picture all aqueous solutions and even all suspensions as having electrically controllable particles of various sorts. Many of them migrate through the solution under direct current potential difference. The particles may range from a bit of sand or clay through bacterial, mineral, animal and vegetable colloids, and filterable emulsions down to and including molecules and ions of all the salts, organic and inorganic. These will mostly migrate and even electroplate out under direct current, unless in some way they are first made iso-electric, or of equal charge to their surroundings. Undissociated salt molecules and those colloidal particles whose natural charges are neutralized by adsorption of ions or of oppositely charged colloids, are the exception to the general rule of electromigration and cataphoresis. Any otherwise neutral particle capable of differentially adsorbing or absorbing more of one kind of ion than another should also act as a conductor under electric impulse. If the Donnan theory of potential drop through cell walls attributed to selective solubilities for the ions is here applicable, then simple organic cells might also tend to move (tropism), depending upon the salts present.

By applying the static field at a given alternating frequency, we periodically induce electric charges which should call forth their counterpart at the extremities of conductors in the vicinity. This seems to suggest that a movement of all charged particles in the field should take place. This movement should continue just long enough during the half cycle to produce the induced charge — polarization — but no long-

er. The important part is that, in any case, this polarization may be produced either by many ions moving a little, or fewer ions moving more.

It happens that electrolytic solutions of the order of resistance of blood, and even such dilute solutions as various tap waters, will give very appreciable rates of heating at different frequencies now available.

Corresponding heating, for ordinary suspensions and pure colloidal solutions, calls for a lower order of frequency. This probably means heating at too low a degree for exact measurement.

When the electromotive force is applied, as in the condenser field, the static state of equilibrium, or polarization should be reached in a time proportionate to the greater concentration of the ions. The heating effect is the measure of the work done in the solution in answer to the induced charges, and this work is a movement, however small, of all the ions or mobilized particles. For maximum heating, this work must be carried on during all the time of each period; that is, over the complete half cycle. If the frequency of alternation of the inducing charges at the electrodes is so low that the induced charges build to equilibrium in a small part of each cycle, then there will be idle time within the cycle without heating. If, on the other hand, the resistance is high (too few ions), then the ions cannot build up the equivalent induced charge within the time periods, or half cycles, and the energy used, or the heating, will be less than maximum. Finally, there will be one concentration for any given frequency in which the time period is just sufficient to cause the ionic motion to be continuous during the entire period, and this will correspond to maximum heating for that frequency.

This may be a crude picture, but with it in mind one can imagine what has taken place and undertake experiments accordingly.

It is also interesting because, if a time should ever come when the wave shape, in addition to the frequency, has also to be considered, we shall have a picture in which any unexpected phenomena will stand out prominently.

While we feel convinced that all the known effects in fever therapy and high

frequency treatments are primarily thermal, it would be of the utmost importance if one could discover the existence of specific bactericidal wavelengths, even if we never understood the real cause of their action. If living conditions were such that some selected frequencies destroyed parasitic life by what would afterwards be found to be internal heating within the parasite itself, without involving any concomitant harmful tissue heating of the host, the results might have useful application.

Other investigators described experiments which, they believe, demonstrate specific bactericidal effects which if realized would be highly desirable.⁽⁵⁾ Who can say that they may not be found? Experiment alone can answer such questions. Some trained mind, knowing the field of electric phenomena, may question specific wave effects, but we have no way of disproving them.

Living conditions usually involve dilute salt solutions which are now known to be most readily heated by high frequency inductions, but this does not preclude new discoveries. When one thinks of the high electrical resistance of fats and oils, for example, one may appreciate that, at least within such media, it might be possible to produce localized heating, even to the destruction of colonies, which are electrically conductive as a whole, largely because they were surrounded by non-conducting material.

Bactericidal Studies

We have been unable to confirm heatless bactericidal actions thus far. To study this point, we first subjected various bacteria in their culture media in Petri dishes (and at different parts of their normal life cycle) to different frequencies for varying times. In all cases where the culture media was not heated appreciably the bacteria continued to live. A long series of short exposures, each period being too short to cause any marked rise in general temperature and each one coupled with a cooling period between treatments, did not seem to affect the growth. When they were killed, it was always possible to explain the fact as a mere thermal sterilization of the medium.

This might not be worth recording, except that it led us to two possibly sig-

nificant experiments. In a sense, we magnified the bacteria into tadpoles. These, being one-half inch long, could readily be observed individually and thus lent themselves well to the experiment. It is true they are not single-celled organisms, but perhaps bacteria, and certainly spirochetes, trichinae, etc., are also quite complex structurally. Accordingly local heating effects might be imagined as easily within the one as the other.

The obvious experiment of using the tadpoles in their normal environmental water was first tried. A single tadpole, introduced into the high frequency field while surrounded by tap water in an inverted T-shaped glass tube, was killed in about ten seconds. But within that time, the water had also risen probably to the lethal temperature. It was then found that the animal could live well enough in distilled water. When this was substituted for the tap water, the animal was killed before the water was appreciably warmed. It was also quite evident that the internally heated tadpole slowly heated the surrounding water. Here was a special case where the medium within the living organism was damaged without involving an appreciable change in the general environmental temperature. It is not at once clear how this fact may be of service, but it is easy to proceed with additional experiments.

The next experiment consisted in placing a number of tadpoles in the tube at the same time. It was noticed that the group was killed more quickly than a single tadpole. The reason for this becomes clear when we recall the antenna effect. Each tadpole bridges a part of the voltage gap and thus helps apply the power to his neighbors. It is as though the condenser plates were brought close up to the extremities of each of the tadpoles.

This again may have no useful bearing, but it suggests that since colonies of bacteria are what we really wish to destroy, and since a single bacterium may be harmless, we should look into the effects indicated by this rough experiment. This might be called the ecological viewpoint.

It is interesting also to note that when Schliephake and Haase⁽⁶⁾ studied the death times of certain staphylococci in ordinary heated cultures, in comparison to cultures

subjected to the field, they obtained destruction in twenty minutes at 60 degrees C., while in the static field it occurred in four minutes at the same temperature. Such observations, however, have apparently not taken account of the form factors of the apparatus nor of local disturbances which may be brought about by groups or colonies. These are illustrated in this article.

As a controllable substitute for small animals like the tadpoles we made capillary glass tubes which were filled with salt solution and sealed.

One of these capillaries was 3 mm. in diameter, 10 cm. long, and was filled for 9 cm. of its length with 1 per cent sodium chloride solution. This was submerged under 100 cc. distilled water in a 600 cc. beaker. It was so oriented in the field that the capillary was at right angles to the plates. The plates were 11 cm. apart. The water in the capillary filled 82 per cent of this distance and also extended nearly across the inside of the beaker. These are important details.

When a field of 30 m. wavelength was applied, the 100 cc. water in the beaker rose 9 degrees in five minutes and 17 degrees in ten minutes.

The experiment was at once repeated, with the single change of first rotating the beaker 90 degrees so that the tube lay parallel to the plates. In this case practically no heating was observed after five minutes.

Three tubes of the same solution, each about one-third the length of the long tube, heated the distilled water a little over half as rapidly as did the one long tube, but then, too, only when the three were lined up across the field. This illustrates what we have called the antenna effect as well as the effect of position and shape of the real conductors in the field.

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EVALUATION OF HYPERPYREXIA

Methods and Treatment *

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The living organism is in a figurative sense strung upon a very narrow margin in the scale of vital thermodynamics. Within this narrow sphere life's processes function normally. When in human and other warm blooded animals the temperature is made to rise or fall above or below the thermic level of 37 degrees C. (98.6 degrees F.), functional and metabolic variations ensue as demonstrated by acceleration or slowing of physiologic and vital activity. It has been stated that life is an adjustment of internal relations to external forces. Heat is undoubtedly the most equilibrating and defensive force utilized by nature in the form of fever, and modern medicine is now learning to imitate nature by means of physical agencies to produce controllable temperature states.

Brief inquiry into the physiologic nature of heat is of importance since an understanding of its normal action may better develop an appreciation of the diverse changes encountered during and after generalized high temperature production. We shall therefore summarize the salient facts regarding the processes which liberate the heat of the body, and the source of the energy associated with normal function. These or their prototype were the most puzzling problems propounded by modern investigators and were of special interest to the clinician utilizing hyperpyretic therapy.

Origin and Discovery of Animal Heat

From the early beliefs that heat was an essence or a substance that found its way in and out of body tissues, or that it was one of the four cardinal elements (heat, air, water and earth), expounded by Greek philosophers as the components of life, a new conception of its intrinsic value has gained ground. It was gradually discovered that there was a relationship between life and oxygen. Small animals confined into poorly oxygenated quarters soon died, lighted candles were read-

ily extinguished, showing that light and life could not exist in an environment of what Priestly called poorly "dephlogisticated air." It remained for the brilliant Lavoisier to make the fundamental discovery that life cannot exist without the substance which he termed "oxygen." He found that heat came from the combination of carbon and hydrogen of the body by the oxygen of the air. Having proved that animal heat is in a large part due to the union of the above mentioned elements, he then investigated if oxygen combined with anything else than carbon and the relation of oxygen consumption at low and high temperatures. His experiments were unfortunately interrupted by the French Revolution and his untimely death by the guillotine in 1794. His preliminary report is however sufficiently clear to show that the mechanism of bodily function is associated with respiration and heat combustion. The absorption of the various foods in the body are in the end converted into heat energy, which in turn governs the mechanistic life cycle of the animal. According to Lavoisier⁽¹⁾, three regulating principles govern the animal machine: (1) "Respiration which consumes hydrogen and carbon and furnishes heat; (2) temperature which augments or diminishes following the necessity of getting rid of more or less heat; (3) and digestion, which returns to the blood that which has been lost by transpiration and respiration."

The question of where the heat of the body took place was left unanswered by Lavoisier and remained for later workers to be discovered. Pflüger, among others, finally showed that the blood had little power of combustion and that this took place only in living tissues during the union of oxygen and organic substance. Heat and carbon dioxide are thus produced even in the cells themselves. Indeed it is only here that the real respiration takes place. As pointed out by Mathews⁽²⁾, "it is the living matter which is burning, not the food substances circulating within the blood." Under normal conditions the living animal

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may therefore be likened to a state which is in constant heat combustion, maintained at a definite temperature by regulatory centers. Energy in the form of food or absorption of radiant energy is taken up by the oxygen atoms of the carbon dioxide molecule. The oxygen is then raised to the active, unstable, anakinetic molecular form in which some of the electrons are rotating in wider orbits than before. The excess of energy leaves the body as heat, the rest being converted into potential energy of work which in turn utilizes the stored energy to maintain the body at a warmer temperature than its external environment.

In health there is a balance between energy conversion of the stuff taken in and the heat irradiated from the body. In disease, provoked by intoxication, infection, or trauma, a general rise or fall of temperature ensues and is manifested in a characteristic fashion. Ordinarily, the tendency is offset by compensatory reactions in both the static and dynamic tissues of the body. Sollman⁽³⁾ has pointed out that a "significant rise of temperature, i. e., fever, will occur only if the change exceeds the capacity of compensation either because it is extraordinarily great or because it involves more than one factor. This break in compensation may be caused by a large number of agencies acting through different mechanisms," such as trauma, infection or intoxication. The heat regulation is altered, due to a disturbance of the factors involved in its control. The energy for increased heat production is furnished by oxidative changes in the body. In fever the metabolic tempo is generally increased, due to acceleration of internal combustion as demonstrated by changes in the blood picture, the pulse, the respirations, the internal secretions, the active hyperemia of the skin, and the mental state of the individual. The picture of fever or that of hyperpyrexia is but an intensification of the normal processes of oxidation which calls into action both the defensive and reserve forces of the body. The production and regulation of controllable fever for therapeutic purposes by means of electrical or radiant appliances is of recent origin and is already promising to become one of the most brilliant contributions of physical medicine.

Controllable Hyperpyrexia

Formerly regarded as undesirable and even

dangerous, the symptom complex known as fever is gradually coming into recognition as a laudable and purposeful manifestation of defense by the living organism. Today it is the lack of fever in the presence of disease that is giving the profession its greatest concern. Instead of regarding fever as a passive force associated with toxic states, modern science is at present critically studying its use and advantages as an active therapeutic agent in a large variety of conditions. At the recent Fever Conference at Dayton, Ohio, forty-one reports were presented by representative physicians on the value of controllable systemic temperature. The general agreement was that hyperpyretotherapy marked the advent of a new era in modern medicine, but was a method often so heroic as to restrict its use to most difficult affections. It was furthermore stressed that fever therapy should be under control of experienced physicians, and administered in the constant presence of an equally experienced technician, and this in hospitals (not offices) well organized and equipped for this purpose.

While it is true that general temperature elevation was an established therapeutic procedure even among ancient peoples, its scientific and critical use was stimulated to the largest extent by the works of Wagner von Jauregg⁽⁴⁾, in 1918, and since then by Whitney⁽⁵⁾, Bierman⁽⁶⁾, Simpson⁽⁷⁾, and many others. As regards the superiority of methods for the production of systemic fever, there is little to choose between inoculation by malaria and other parasites, injection of foreign proteins, vaccines, sulphur in oil, or electrical and radiant energies. There is however a definite swing towards the physical methods now in current use as compared with other measures. While hyperpyrexia is the common phenomenon created by all measures, our choice must necessarily be influenced to avoid objectionable or provocative factors. Thus to cure a disease by imposing another disease, even though the latter is also curable, is an objection not born out of sentiment alone. There is evidence at hand to prove that malaria carriers have infected other patients in the same institution. The controllability of fever produced by physical agents coupled with the elimination of possible infections are in themselves sufficiently valuable to swing general sentiment in their favor.

Reaction of Bodily Tissue to Hyperthermia

Contrary to general opinion, the reaction of the tissues to excessive fever attains a picture beyond that associated with physiologic processes; rather should it be regarded as patho-physiologic in nature. The inability of the body to balance its heat irradiation with its internal heat creation places an extra burden upon all vital functions with acceleration of physiologic processes. If the fever is relatively low, say 104 degrees F. for the duration of one to three hours, the physiologic changes will naturally not reach the high and critical peak (105-107 degrees F.) advocated for the more intractable conditions in the literature. The choice must remain with the physician fully oriented in both procedures, because there is sufficient evidence favoring either method.

The cutaneous surfaces appear to bear the early brunt of the treatment. Energy is conveyed through the skin by conduction or conversion and soon becomes manifest as fever. The temperature of the skin varies in different parts and causes vascular alteration which produces sweating and evaporation of fluid, losses in CO_2 , and pilomotor changes. To prevent temperature elevation, the body makes use of its heat regulatory apparatus to evaporate the water from the lungs and skin and to shift the heat from the skin to the deeper parts by conduction and radiation. The circulation in the skin is augmented, this being accomplished by depletion of the interior parts. The loss of water is sometimes so copious as to require replacement during treatment. Drinking of large quantities of cool 0.6 per cent NaCl water should be encouraged, because of the three well known regulatory qualities of water pointed out by Bierman⁽⁸⁾: (1) Its specific heat capacity which favors storage of heat; (2) its heat evaporation, which permits rapid elimination at high temperature; (3) its heat conductivity which allows its rapid equalization with the fixed tissues of the body, minimizing the possibility of injury from local overheating from within or without*. Patients often lose as much as five pounds during a single treatment, this fluid coming as it does from the blood, the intestines, from the subcutaneous tissues and the muscles, tends to produce un-

desirable concentrations of the retaining fluid and the withdrawal of certain of the necessary salts from the body.

The pulse rate increases, its rapidity being generally proportionate to the temperature elevation. The increase is approximately 6 to 10 beats per minute for each rise of one degree F. The volume is also influenced. The initial increase is due to additional fluid absorption from other parts of the body, and as sweating becomes profuse, a concentration occurs. The velocity of the blood flow is also accelerated. Blood pressure at first shows slight systolic elevation and then a reduction with increasing temperature. The diastolic pressure usually begins to fall with the rise of temperature, receding to 50 to 60 mm. Hg. in contrast to 120 to 80 mm. Hg. for the systolic. The rate of respiration is increased, ranging from two to twelve per minute for every degree F. At 105 degrees F. per rectum, the average number of respirations is about 30 per minute.

As the temperature rises the white cells increase; indeed, the entire hemopoietic system seems to be stimulated. The percentage of polymorphonuclear cells is increased and that of the lymphocytes and monocytes correspondingly lowered, this picture persisting several days after treatment. Hyperpyrexia also influences diminution of alveolar CO_2 tension associated with alkalosis. The hydrogen ion concentration shifts toward the alkaline side with a rise of the plasma pH to even as high as 7.70 and 7.74. Gastric secretion is generally reduced, with marked lowering of both free and total acidity.

Undoubtedly the outstanding effect associated with hyperthermic treatment is the breaking down of infectious products within the body. The more sensitive the organism or toxin is to heat, the more lethal and shorter the death time. With the failure of chemotherapy to provide the much sought for "magic bullet" of Ehrlich, investigators began to search other fields and methods and discovered that one may actually destroy the responsible organisms *in vivo*, at the same time favorably influencing the state of the disease itself. Contemporary literature is replete with evidence that certain microorganisms can be more readily influenced by heat than others. The *treponema pallidum* has been consistently destroyed *in vitro* with temperatures between 39 to 41.5 degrees C. (102 to 106 degrees F.)

* The author gratefully acknowledges his debt to and his appreciation of the scholarly contributions of William Bierman, whose opinions on fever therapy have been liberally embodied in this report.

when heated from five minutes to one hour. The gonococcus has been found to possess a variable state of resistance. The older the strain, the longer and higher the temperature required to destroy it.

The object of all thermal agents to produce controllable hyperthermic states is essentially to provide the most effective reaction under a most convenient and comfortable environment. The first consideration should be efficiency, the last, — cost. Whether one chooses for this purpose diathermy, radiotherapy, infrared with or without regulating humidifiers, electric cabinets, or electric blankets, the general purpose is to insulate the patient in a form of controllable heat radiation, in order to raise the temperature of the body from normal to its highest requirement in a specified period of time, and to maintain this fever state from one to eight hours with no untoward effects. There is general agreement that for excessive high and prolonged temperature treatments, the hospital is the best place. If as pointed out by Atsatt⁽⁹⁾ favorable effects are known to occur with temperature elevations below 104 degrees F., the convenience of an efficient and portable apparatus such as an electric heating blanket, which may be employed in places other than the hospital, is a practical consideration. At no time during any form of fever administration should the patient be left alone.

Nervous and pampered patients may become apprehensive and excitable, and the few who tend to develop a delirious state may get out of bound unless use is made of sedatives with intelligent nursing. Simpson has repeatedly stated that very few patients experience delirium, nausea or vomiting since he has instituted the chloride replacement regimen (3-5 liters of cold 0.6 per cent NaCl solution by mouth during each treatment). He has found the best sedative to be the "salesmanship" of a cheerful nurse-technician who is awake to her responsibilities. However, in order to reduce the tedium of the long sessions of treatment and to minimize fatigue, sedatives may often be required. The most satisfactory are codeine, pento-barbital sodium (nembutal), and sodium amytal. Morphine should be avoided because of its tendency to cause vomiting. Initial examination of each patient's physical state is of prime importance to guard against cardiovascular and renal complications.

Methods

Of the methods now in vogue, experience has pointed out two basic routes for hyperthermic therapy. Of these the high frequency currents (diathermy and radiotherapy) are theoretically best suited to produce the most uniform general heating. Under ideal conditions diathermy should create a heating through, but the variable resistance of the tissue tends to shunt the current through bypaths and is left for the circulation to carry the heat to distant parts. Under ordinary circumstances such an event would be a minor objection, the most outstanding being the risk of burns by arcing from poor contact electrodes due to faulty fixation or the restlessness of the patient. Moreover since experience has demonstrated the superiority of quicker and higher temperature effects than is obtainable by average diathermy, one must either buy special high amperage diathermy apparatus at an extra cost or resort to measures equally and perhaps more efficient.

In many respects the Whitney radiotherm is an answer to the objections encountered with diathermy. It is an instrument employing short wave radiation of 30 meters, and embodies two, 500 watt radio transmitting tubes. The apparatus is so constructed that the patient is placed on a canvas stretcher between two equally protected and large condenser plates. The entire body with exception of the head lies within the space of a semi-cabinet covering. The patient is insulated by means of a hood. The heat created is endogenous in character and passes through the resistance of the patient in greater uniformity than with diathermy. Care must be maintained against burns due to arcing when excessive perspiration accumulates near the condenser electrodes. The desired systemic temperature is quickly reached (90 minutes is the average time) and the patient is then removed to a bed and the fever retained by external heat from hooded carbon filament lamps. It is essential that during the entire seance temperature readings be recorded at 10 minute intervals as a protection to the patient. Pulse and respiration changes are noted at the same time. A clinical thermometer is now considered the preferred method for temperature determination.

Bierman and Horowitz⁽¹⁰⁾ have added to the efficiency of radiotherapy by showing that the temperature of a localized area of the body

can be raised above that of the entire body. With the patient between the condenser plates, an electrode is introduced within the vagina and it in turn connected through an ammeter with an auxiliary metal plate near one of the large condenser electrodes. "With this technic it has been possible to develop temperatures reaching between 110 to 116 degrees F. as indicated by a mercury thermometer inserted into the vaginal electrode." (Bierman.⁽⁸⁾)

The most brilliant results have been obtained in gonococcal pelvic disease. In infections of the female genital tract, the failures of established methods have especially emphasized the dramatic restitutions obtained by fever therapy. While the treatment is intense and heroic the results are spectacular and permanent. Acute and subacute infections have yielded more readily to this form of treatment, but even the most chronic with or without articular involvement, have been restored to normal health. Chronic affections must be submitted to higher temperatures and to a longer series of treatments. The regularity with which confirmatory reports have borne out the original observations of Bierman is an index that this form of therapy offers the best method to combat gonococcal involvement of the female genitalia. Additional proof is now at hand that equally striking results have also been obtained in like infections of the male genitalia and its complications.

That similar effects may be attained with instruments utilizing air conditioned and thermostatically controlled fever chambers has recently been pointed out by Desjardins, Stuhler and Popp⁽¹¹⁾. The fever chamber used by these workers is known as the Kettering Hypertherm, an instrument developed by the collaboration of Dr. W. M. Simpson and Mr. C. F. Kettering of Dayton, Ohio. The apparatus resembles an horizontal box made to enclose the entire body of the patient, except the head which projects and rests comfortably on a shelf. During treatment sliding panels of the chamber are hermetically sealed. The machinery controlling the humidified air and heat is located at the foot of the apparatus and the properly moistened heat is forced into the chamber circulating around the patient at the rate of ten times per minute. The patient's body is covered with a single blanket. By means of the sliding panels

and the glass windows any part of the patient's body is easily reached, the skin readily observed for all natural needs or for recording of temperature. In an emergency the apparatus can be speedily thrown open and the patient withdrawn. Systemic hyperpyrexia can be rapidly attained and steadily maintained.

Desjardins and his co-workers have advocated a rectal fever level of 106 to 107 degrees F. sustained for six to eight hours on alternate days, for the cure of gonococcal infections. Less than this is inadequate for the majority of patients. It is their contention that "in gonococcal infections there is no doubt that the therapeutic efficacy of fever is absolutely a function of the degree of temperature attained and of the time during which an adequate degree of temperature is maintained." The high percentage of cures was due to the maintenance of a precise technic which included as its central theme the production of hyperthermic states on alternate days until the patient showed a negative smear and became symptom free. Of thirty-three patients suffering from urethritis or from urethritis complicated by cervicitis, salpingitis or arthritis, twenty-nine completed the course of treatment; twenty-five were cured; the remaining four were uncured because the required temperature could not be consistently attained. In this group of cured patients mention is made of a controlled diabetic who also took the treatment with local benefit and with no untoward effect on his diabetic state, proving that diabetes is not a contraindication to hyperthermy. In general the technic utilized at the Mayo Foundation is little different from that in current use by any experienced physician and with any other apparatus. When the cases are properly selected and the technic is rigidly carried out, there is little choice between any of the methods now in vogue. Given an efficient apparatus, it requires experience, intelligence and conservative management to obtain results of a most striking character.

Dangers and Contraindications

It hardly needs pointing out that where one employs methods so critical, one comes close to stretching vital activity to the breaking point. Hyperpyrexia may well be likened to surgery, with its potential dangers and spectacular recoveries. It is thus a procedure only to be employed when other measures have been tried and found to be ineffective. Its

dangers according to Bazett⁽¹²⁾ are: (1) Overheating of the brain beyond vital endurance—a remote danger; (2) pronounced hyperpyrexia associated with lowered CO₂ tension and alkalosis. The body's automatic compensation for this circulatory state is the creation of more acid blood by increase in temperature which is followed by alkalinization. (3) Dehydration through excessive loss of fluids by sweat and circulatory failure. Since it is a part of good technic to bathe the face with cold, moist towels and to apply an ice cap to the head, dangerous brain temperatures are usually a remote complication. Hyperpyrexia can be controlled by avoiding rapid heating of the patient. Circulatory failure as demonstrated by cyanosis and the aural pallor, rapid pulse and respiration, can be avoided by immediate cessation of treatment and the use of circulatory stimulants, as adrenalin and caffeine. Forced fluid intake is encouraged by drinking of tea, lemonade, or 0.6 per cent solution of sodium chloride. Minor burns have been reported, but since healing is rapid their danger is minimal and are only mentioned as a plea for greater vigilance.

Undoubtedly certain diseases or physical states preclude the use of artificial high fever therapy. Since such treatments are strenuous tests of the patient's endurance, the Council on Physical Therapy⁽¹³⁾ has given as contraindications, cardiovascular diseases, such as myocardial degeneration or with valvular, coronary or other cardiac and vascular abnormalities; impaired renal function from organic disease, with excessively high blood pressure or arteriosclerosis, or with tuberculosis, uncontrolled diabetes, or far advanced syphilis of the central nervous system. As a precaution against adventitious failures, the Council also has advocated complete physical and laboratory examination, these to include electrocardiograms, sedimentation and coagulation time, and all of the established tests employed in the study of syphilitic patients.

Clinical Results

The restraint with which the collective and separate reports of the members of the Fever Conference group have always been formulated has been largely responsible for the scientific recognition accorded to the method. It can therefore be predicted that given the conditions about to be enumerated, it but requires a duplication of methods, technics and

intelligent administration to produce equally striking results. As already pointed out the brilliant work of Wagner von Jauregg was responsible for the interpretation of fever from a dangerous to a laudable state. The high fever produced by the inoculation of malaria organisms resulted in such favorable and clinical remissions that other and less dangerous heat producing agents came into use. The results justified the theory and since then neurosyphilitic conditions have been equally relieved by the artificial but controllable fever methods contributed by American research. In the recently published monograph on Electropyrexia in General Paralysis, Hinsie and Blalock⁽¹⁴⁾ have shown in an equally divided series that by comparison with malaria, heat by high frequency waves produced essentially the same body changes as heat by other means. This finding is supported by other workers over the world and removes from this study the speculation of the existence of some specific change induced by malarial organisms. The responsible remedial effect is undoubtedly due to the changes accompanying temperature elevation and not to some specific protein action.

The most rational therapeutic procedure in syphilitic infections was first introduced by Kyrle of Vienna, and pointed out by Simpson at the Fourth Annual Fever Conference in New York, who adopted its principle for the treatment of early and late complications. According to Simpson this was first described in the monograph by Natuschka and Rosner⁽¹⁵⁾ who confirmed the brilliant results of the combined use of the salvarsan-malaria-salvarsan method. Of 232 Wassermann-positive patients with early syphilis, the blood Wassermann reaction was favorably influenced in 230 (99.1 per cent), and after five years none had developed positive reactions in the blood or spinal fluid after a single combined course of treatment. Instead of malaria, Simpson⁽¹⁶⁾ uses the Kettering apparatus to raise the temperature of the individual. Approximately fifty fever hours are administered, usually on alternate days of about five hours duration. This is perhaps the most promising method advanced and is applicable with variations to every condition where hyperpyrexia is at all indicated. In neurosyphilis he combines bismarsen, iodobismittel or tryparsimid with sustained fever at approximately 106 degrees F. for at least fifty hours, given at weekly

intervals over a period of ten weeks. The chemotherapy is given one-half hour before the fever is initiated. After the completion of the course, the treatment is followed up by specific therapy at weekly intervals for twenty weeks.

Of 117 luetics studied by Simpson since 1931, 87 complete the full course of treatment. Of 16 patients with dementia paralytica, 12 obtained complete remissions, two were markedly improved and were restored to a working status, one showed moderate improvement and one no improvement. Of seven taboparetics, six showed improved mental orientation, root pains subsided in all, the ataxic gait was improved in all except one. In nine patients with *tabes dorsalis*, ataxia was a prominent symptom in eight. Of these, seven showed improvement varying from total restoration to that of 50 per cent. The lancinating root pains were abolished in all, as was the case in one with cord bladder symptoms. The spinal and blood Wassermann reactions were also proportionately influenced in a favorable manner. Similar observations have been recorded by Bierman but hardly so striking since fever was the only method resorted to in his cases. However, his results in gonococcic infections with or without pelvic complications have been so striking as to warrant adoption of his as well as Simpson's technique in the conditions reported by them.

While there is evidence pointing to the significant value of sustained fever therapy for many chronic and hopeless conditions, opinion is still in the formative stage regarding its special value. In this group mention should be made of the consistent remissions obtained in multiple sclerosis. Schmidt has treated over 100 patients with results varying from complete remissions to marked improvement. Considering the tendency for spontaneous remission in these cases one must be guarded against advancing any final conclusion. Schmidt however, on the basis of the largest experience had by anyone feels that the treatment has definite value.

In arthritis as many disappointments as encouragements have been encountered. While it is practically a specific in gonococcal arthritis, it has yielded indifferent results in the hypertrophic group and very encouraging ones in the chronically infectious group. Patients with periarticular fibrositis who show a

low sedimentation rate appear to improve more readily. A similar impression has gradually been gained as to its value in asthma. Hyperpyrexia appears to be an aid to the allergist in the treatment of intractable asthma. The relief obtained from this heroic method is not permanent, but is of value where other measures have been exhausted. Enough experimental and clinical evidence has been accumulated to point to the unusual value of controlled hyperthermic methods and to indicate its scientific merit as an adjuvant in modern medical practice.

Conclusions

1. Heat maintenance of the body is a physiologic process and fever is an exaggeration of internal combustion, during which the mechanism of heat irradiation falls below that of heat manufacture.
2. Heat may be generated in living material by means of various physical agents, chemicals, or biologic products.
3. Electropyrexia when controlled and sustained produces by absorption and conversion of energy an acceleration of the circulating blood in the body and thereby elevation of temperature of the deepest viscera.
4. Under the influence of electropyrexia by high frequency or radiant energy, physiologic and biochemical changes ensue which primarily influence the oxidizing powers of the cells, alteration of blood volume, the water balance of the body, and the like.
5. The most favorable results have been obtained in neurosyphilis, gonococcic infection with or without complications, such as pelvic inflammation and arthritis. Other distressing affections have also been favorably influenced — chronic, infective arthritis, multiple sclerosis, but not with the same consistency. Hypertrophic and osteoarthritic involvement show the least amount of clinical amelioration.
6. Since sustained high temperature is a definite strain on the body, precautions must be observed prior to and during treatment. Complete preliminary physical and laboratory examination is essential to guard against untoward effects.
7. Sufficient critical evidence is now available to indicate the scientific merit of hyperpyrexia as an adjuvant to modern therapy.

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DEVELOPMENT OF FEVER THERAPY IN THE SANTA BARBARA COTTAGE HOSPITAL *

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and

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About half a century ago Wagner-Jauregg, conceived the idea that by producing artificial fever it might be possible favorably to influence paresis. Erysipelas and malaria were his chosen "fires."

Under modern conceptions and facilities his method seems unnecessarily drastic. With our present methods of producing electrically generated heat, the "cleansing fire" becomes a servant of our will, controllable and docile. This method did not come into being as the result of any one great genius — rather it grew through trial and error as the product of many minds and much work.

Systemic Heat Generation by Electricity

In 1929, shortly after Dr. W. R. Whitney

recognized the production of fever in men working within the field of a powerful high frequency oscillator, the General Electric Company built five radio frequency outfits for experimental research in the field of fever therapy. Through the courtesy of Mr. Darnell of the General Electric Company, and the co-operation of Dr. Ullmann, the Santa Barbara Cottage Hospital was fortunate in securing one of these apparatus.

It was essentially a short wave radio transmitter using vacuum tubes for oscillation, the energy output from which was distributed to two large insulated condenser plates. These plates were adjustable in a horizontal position, enabling a patient to lie on a non-metallic bed between them and enter the electrical field set up by the operation of the apparatus. The principle may be likened to that of diathermy

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except that there was no direct contact and the energy output was tremendously increased, being approximately equal to a one kilowatt broadcasting station.

The technic of operation with this device was highly unsatisfactory though a number of patients were later given treatments with it. The passage of the oscillating current generated heat in the tissues without question and it was possible to slowly raise the patient's temperature. However as soon as the patient began to perspire freely a serious handicap was encountered. An uncomfortable burning sensation developed in the region where perspiration was appearing and soon this sensation became unbearable. It was found that eddy currents were set up in each little droplet of water and if the treatment was persisted in small blisters would develop. Thus the temperature elevation was limited by the appearance of perspiration. An attempt was made to eliminate the moisture by wrapping the patient in cellucotton, but even this did not prevent arcing and burns. Following out suggestions from Charles M. Carpenter, a celotex box was so constructed that the whole could be slid in between the condenser plates. A current of warm air was then blown into the box by means of two hair dryers, in an endeavor to keep the patient dry. This method was not only awkward but more or less unsuccessful in lessening the discomfort of the patient.

The primary purpose of this courtesy on the part of the sponsoring company was to stimulate research in this new field and so our biochemists, a radiologist and one of us (R.F.A.), an orthopedist, undertook further studies. A number of papers were written on the biochemical changes in the blood and urine as the result of elevation of temperature.

This experimental work went on for two years—always with the belief that artificial fever therapy by some method was a fruitful field of research. A paper was written based on the treatment of a few cases of arthritis, but a conservative Eastern Journal refused to publish it on the ground that the subject matter was too new and bizarre.

Early in 1931, the next step in the development of fever therapy came with the introduction of large or "super power" diathermy apparatus. These machines were capable of developing a current of two million oscilla-

tions per second with a power range up to 10,000 milliamperes.

The output of the diathermy apparatus was distributed to three electrodes, one large one covering most of the back and the other two to be applied to the chest and abdomen. These electrodes consisted of block tin (unfenestrated were found to be equally as good as the more fenestrated variety). The metal was mounted on a sponge rubber backing, causing it to mold more closely to the walls of the torso. The electrodes were applied over saline moistened cotton pads by means of a tightly laced canvas corset—laced just as tightly as the patient could stand and then just a little more to make sure that the electrodes were in perfect contact and thus insure against the possibility of burns.

With this apparatus we had an efficient, even if not comfortable or especially safe, method of producing heat. The question which then faced us was the problem of conserving this heat and preventing its dispersion by radiation, conduction and convection. The initial attempts, common at the time, were in the line of pure insulation. The patient was covered above and below with many layers of blankets—as many as eight woolen blankets being used. Insulation was accomplished to a moderate degree but at the expense of considerable weight bearing and discomfort to the patient.

Following the lead of other institutions utilizing electropyrrexia, a large canvas bag of the zipper type was made to enclose the patient and covers and this was found to be an improvement as it materially lessened the number of required blankets. However, the patient was still uncomfortable and markedly restricted in his movements.

The greatest advance in the production of fever therapy came with the application of the idea that if positive heat could be added to the system instead of mere insulation greater benefit could be accomplished. This was suggested in a personal communication from Dr. Stafford L. Warren and an immediate trial was instituted. A box or cabinet was constructed out of celotex panels approximately 2 feet 6 inches wide, 6 feet long and 2 feet high. Inside, just under the top were placed ten sixty watt carbon filament incandescent bulbs so connected to a delicate thermoregulator that the turn of the dial would change the temperature of the air within the cabinet

a fraction of a degree. The head end of the cabinet was closed by a rubber sheeting drop and the whole box was insulated by a blanket cover. This device was then suspended over a firm bed by means of ceiling pulleys through which it could be raised or lowered at will.

The use of this box entirely changed the aspect of the treatment as far as the patient was concerned, for now he could lie unhampered, move his extremities freely and shift his position from time to time. As compared with the above the awkward, uncomfortable and dangerous diathermy procedure was a wearisome one.

A natural outgrowth of the idea that fevers could be produced by moist heat alone without the necessity for diathermy saw its fruition early in 1934, in the apparatus which is in use at the present time. It fulfills two essential requirements; it is *safe and simple*. Using the cabinet which has been described, the new construction was not complicated. A box was built to stand upon the floor, the top of which was so arranged that a four inch grating ran along each side, leaving a solid center panel of 22 inches for the patient to lie upon. The grating was blocked down 18 inches from the head end to prevent the escape of the hot air around the pillows. In the bottom of the cabinet was arranged a curved full length reflector on which were mounted three of the common 600 watt heating elements. Suspended above these heating elements was a full length trough with a wide evaporating surface to be partly filled with water. The heating elements were wired so that all three, two or one could be in use at one time.

A clinical trial demonstrated that the worrisome diathermy was a thing of the past, for the fever was elevated even more quickly than with the former method and there seemed to be less acceleration of the pulse rate. It was found that the water in the trough did not evaporate quickly so a separate flat heater was attached to this part and the humidity was then found to rise satisfactorily as determined by a comparison of the wet and dry bulb thermometers.

At last there seemed to be a safe and simple method for the production of artificial fever. An Eastern company is manufacturing a somewhat similar device at the present time.

The technic is simple—the temperature is raised by the combination of all heating ele-

ments, the generators below and the carbon bulbs in the cabinet. Before the peak is reached the generators are turned off and the patient allowed to "coast up" to the desired level. The temperature is then maintained by means of the sensitive thermoregulator adjusting the easily controlled carbon bulbs. After the desired period of fever has been administered all heat is turned off, the cabinet raised by means of the ceiling pulleys and the patient covered with three blankets. These are removed one at a time until the temperature falls to 99 degrees F. when the patient is returned to his room. Here check temperatures are recorded each half hour for four hours to guard against a possible secondary rise.

Other Methods of Producing Hyperpyrexia

There are numerous other methods of systemic fever production. Several have been tried at the Cottage Hospital.

The so-called "electric blanket" seems at first thought to be an efficient agent of raising body temperature but in the hands of many observers it has been found to be unsafe for the prolonged higher fevers as occasionally burns have resulted, even with the utmost care.

Several modifications of the steam cabinet have been used but none are as facile in control as electrically generated heat.

Short wave diathermy has been hailed as the acme of fever therapy devices if one would believe the claims of the manufacturers, but it is subject to the same limitation of safety and comfort as was the radiotherm. In a brief experience with a popular short wave apparatus it, too, was found to be productive of arcing in perspiration droplets. Furthermore as with the superdiathermy apparatus, there are electrodes to be kept in place and an expensive piece of apparatus to buy. It is felt at the Cottage Hospital that the short wave production of fever does not fulfill the essential principles of "safety and simplicity."

A somewhat similar device using high frequency in the form of electromagnetic induction is also on the market but it has not been tried at the Cottage Hospital.

Dry cabinet heat will raise temperatures safely, but with considerable discomfort and only with a considerable prolongation of the period of initial rise.

Hot water baths result in a rapid rise in temperature, but are less easily controlled as

to rate and height of rise. They are also extremely exhausting and cannot be maintained for sufficient periods for effective hyperpyrexia. Even for pyrexia they may lack in an important function, namely, skin elimination.

A method has been tried elsewhere involving the use of blankets for insulation, with positive heat supplied by a large body baker, but the discomfort of the "mummy-like" wrappings around the patient in addition to the lack of fine temperature control may keep this method from becoming popular, it is felt.

Development of Temperature Recording. The first temperatures were taken orally and recorded every fifteen minutes. These were found to be unreliable as the fever progressed because of mouth breathing and the frequent administration of water.

Axillary estimations were then tried and were scientifically satisfactory but disturbing to the patient and awkward to take.

The most efficient and accurate method is that which is now in use. An electric pyrometer energized by the ordinary house current is connected to a sensitive thermocouple which is inserted into the rectum. The olive shaped device is self-retaining. The temperature is read directly on a large scale and is accurate to two-tenths of a degree. Thus it is possible quickly and easily to record temperature readings every five minutes, — giving the technician ample opportunity to observe fluctuations and forestall untoward results.

Administration of Drugs. The whole gamut of sedatives, hypnotics and narcotics has been tried. Pure sedation is not sufficient to make the patient comfortable. Drugs which include hypnotic action were often found to cause gastric distress when given during the fever. Morphine often depressed the respiratory center to a considerable degree, especially during the height of the temperature elevation even to the point where prolonged periods of apnea were produced. An additional disadvantage under the old system of diathermy was the danger of burns developing during a deep narcosis.

Out of the long list of drugs that have been tried it has seemed that dilauid gr. 1/32 with scopalamine gr. 1/100 was the most efficient for the initial medication with a repeating dose of dilauid gr. 1/32 as needed.

The Control of Water and Salt Balance.

To give or not to give water during the treatments? On the one hand if it is desired to change the conditions under which organisms are living with the purpose of exterminating them, as in gonococcal infections, then water should be restricted. On the other hand if the purpose is to wash toxins out of the system as in the low pyrexia for arthritis, then copious quantities of water are essential. Thus each case is a problem in itself. In the main however, in the experience at the Cottage Hospital it has been found that the patient's system reacts better with fairly large amounts of water (2000 to 3000 c.c.) avoiding dehydration and the consequent instability of the body's heat regulating mechanism.

The loss of salts through perspiration should be compensated for by the addition of the various elements to the drinking water as this procedure markedly reduces the fatigue of treatment. Approximately 1000 c.c. of 0.6 per cent solution may be given during the treatment and strangely enough if given at the height of the fever this solution does not taste particularly "salty." However we have found that this administration usually leads to nausea after the treatment. Instead, we are using 2 drams of a prepared mixture containing sodium and potassium bicarbonate with small amounts of calcium and phosphorous (citrocarbonate) which to some extent compensates for salt deficiency.

Development of Technic

The technic of producing artificial fevers has been in a constant state of flux. Standardization has been almost impossible due to the constant improvements in apparatus, the necessity for trying out of new procedures and the diversity in types of patient. However as much as one's success depends upon a nicety of judgment acquired only by experience, there gradually has been built up a certain set of general principles in the production of fever.

Preparation of the patient for fever therapy consists of a thorough physical examination, the forcing of fluids for twenty-four hours, a cleansing enema and a scanty breakfast.

Light narcosis is necessary for hyperpyrexia, the lower pyrexias are attainable without it. As has been stated, dilauid and scopalamine have been found to be most satisfactory in carrying the patient through what

would be otherwise a somewhat trying experience.

Fluid intake is important, the amount depending somewhat on the type of case, averaging about 50 c.c. every 20 minutes. Two drams of mixed salts are supplied.

The temperature, pulse and respiration are taken and recorded every twenty minutes. An additional check is maintained by five minute temperature readings during the height of the fever.

An electric fan and ice compresses to the head often add to the comfort of the patient but these aids should not be started too early as their cessation may be followed by protest, and so these cooling procedures are used only when necessary.

Ice compresses over the heart and in the axilla often are used to slow down an advancing pulse rate. Evidence of impending circulatory collapse such as a rapidly increasing pulse rate, intense facial cyanosis or marked fall in blood pressure call for immediate termination of the treatment.

The moist heat generation is regulated according to the rise of temperature in the patient which varies according to weight, metabolic rate, ease of perspiration and probably other factors. In general the larger patient heats up more slowly. It is planned to induce a rise of 0.8 degree F. every 20 minutes and it is surprising how with experience a predetermined temperature of 105 degrees F. can be plotted and maintained with a variation of less than 0.2 degree. The maximum rise can be obtained in 90 to 105 minutes, the temperature is then held constant at the desired level for 3 to 5 hours and then allowed to fall. At this time the cabinet is raised, the patient is covered with blankets and then allowed to cool down by removing the blankets. The patient is kept in the fever therapy room until his temperature is normal. A half hour check is then continued for four hours to forestall a secondary rise.

Desirable Ranges of Temperature. For a pyrexia whose function is elimination or a change in metabolic or circulatory rate and where the avoidance of fatigue is a factor, it is felt that a temperature of 101 degrees F., held not over one-half of an hour is sufficient. The moderate hyperpyrexia for the usual gonococcal infections usually has 104 or 104.5 degrees F. as a maximum and is held there for three hours.

The higher hyperpyrexias for luetic infections usually are set for 105 or 106 degrees F. with a duration of five hours at that level.

A well executed fever therapy treatment should give a temperature curve with an absolutely flat plateau at a predetermined point but this requires constant care, skill and efficiency on the part of the technician.

Methods of Treatment in Emergencies. Emergencies arise in every form of active treatment and as an ounce of preparation is worth a pound of deprecation, steps have been taken to be ready for them. The body's thermal regulating center seems occasionally to become upset by too vigorous a rise in temperature as do also the cardiovascular and respiratory systems.

An intravenous set is always in readiness, for intravenous fluid is a quick way of cooling the body as well as supporting a circulation which is failing from too much dilatation. An intravenous digitalis preparation may be given for weak or thready pulse which does not seem severe, or may be added to the venoclysis in the more serious case.

With respiratory embarrassment an intramuscular stimulant may be given, but in the two instances in which it has been used carbonogen with rebreathing has stimulated the respiratory center satisfactorily.

For undesired and unanticipated fever above 106 degrees F. the cabinet is raised and ice to tepid sponging is used until 105 degrees are attained. Ice packs are placed to the forehead, back of neck, axillae, groins and over the heart. Ice colonic irrigation will cool the body but should be followed by tepid enemas to avoid intestinal cramping.

Types of Patients

A surprising range of diagnoses are recorded on the therapy charts. In general however we have limited treatment to cases in which infection or abnormal metabolic processes seemed to play a part. It is to be noted that those infectious cases accompanied by a natural fever respond less favorably than afebrile cases.

Of the infectious disease entities the gonococcus invader is probably the most susceptible to heat. Gonococcal arthritis, seminal vesiculitis, prostatitis and epididymitis have almost universally shown improvement. Some strains are quite highly heat resistant however, requiring 105 degrees F. or over to ob-

(Concluded on page 498)



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EDITORIALS

ELECTROPYREXIA

The dictum of Hippocrates that fire will cure where medicine will not, has in recent years gained considerable support by the confirmation that controllable high fever induction has favorably influenced a number of chronic affections. That this oracular concept could have been revived and modified by actual experience at the very time when the world was in greatest travail is proof of the truism that extraordinary times lead to extraordinary events, and that strife, struggle and starvation enervate only the masses and stimulate the individual to greater activity. At a period when the military and political fortunes of the Central Powers were at lowest ebb, Wagner v. Jauregg,⁽¹⁾ in 1918, reported a cure of general paralysis by means of fever induced by malarial organisms. The dramatic restitution of these incurable patients gave impetus to extension of fever therapy of other types of infection, the study of various methods of temperature elevation and the reactivity of the various constituents and organs of the body.

While apparently Jauregg's contribution is as revolutionary as it is new in form, it is evident that basically it rests on the experiences gained from the Hippocratic era

down to August Bier.⁽²⁾ While Hippocrates has empirically evaluated intense heat (fever) as a therapeutic agent, it is due to Bier that the concept of fever as a disease *per se* has been changed into its physiologic interpretation as a "laudable" expression of nature's defense against infection. Bier recognized that the proper procedure in therapy is not to administer so-called antiphlogistics but to enhance the phenomenon.

In the short period since Jauregg's study a new orientation in fever therapy has been developed for the purpose of avoiding the introduction of foreign organisms, and substituting for it physical methods. Though at first obstacles were encountered both in apparatus and technics, these were gradually overcome so that at this time we have at our disposal measures which are as scientifically sound as they are clinically effective. It does not appear to be a matter of especial importance whether artificial fever is brought about by hot baths, electric blankets, high frequency current and short wave radiation, or thermostatically controlled infrared radiation, since any and all of these measures tend to yield about the same effect. Whatever difference in clinical value there is, applies solely to the controlled method of fever production, since

it affords us the means not only to create a rise of temperature more rapidly than is attainable by the others but also to sustain and regulate the fever at will. That these characteristics are valuable and in certain instances even essential, is evidenced by superior clinical results. This is not to be interpreted that all other methods are to be regarded as obsolete, for they too have their clinical value, so that it is a matter of determination of special indications for one or the other agent. In this respect the studies of Simpson⁽³⁾ and Bierman⁽⁴⁾ point out that selection is influenced by the gravity of a given case. Thus when for therapeutic purpose excessive degrees of fever must be attained, the strict control under which it must be carried out necessitates not only a definite method but also hospitalization. These authors make use of specially constructed apparatus which embody all characteristics of sustained hyperpyrexia under thermostatic control. At the same time it cannot be overlooked that such a procedure is decidedly heroic and therefore presupposes not only absolute familiarity with its mechanism but sharpest clinical supervision. Consequently this method is not one for the novice or general practitioner but for the specially trained physician. It is fortunate that milder forms of hyperpyrexia treatment are indicated in a large group of cases which do not require hospitalization, so that a rich field of usefulness is opened to office practice. Even for this group effective results will be obtained only if technically correct procedures are meticulously carried out. This new field of therapy is one which any physician familiar with the principles of physical therapy should learn to master.

Apart from the purely technical problem the clinical indications require serious consideration. This is stressed by Kobak⁽⁵⁾ and Atsatt,⁽⁶⁾ who elsewhere in this issue present their experiences and views on the present status of electropyrrexia. Both authors are agreed that hyperpyrexia has already demonstrated its therapeutic value in a comparatively large group of diseases, but at the same time they do not fail to express a warning that it is not altogether devoid of certain risks and limitations. Familiarization with their expositions should safeguard the interests of both patient and

physician and be productive of therapeutic results which are virtually unattainable by other therapeutic procedures.

Like all new discoveries there is room for simplification of the mechanics as well as technic of application. It is to be hoped that the continued cooperation between the various investigators will bring about desired improvements in the not distant future. Meanwhile the benefits that can be attained in a large number of patients with affections that have been resistant to established methods should not be withheld.

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PROBLEMS IN ELECTROSURGERY

Mock⁽¹⁾ in a meritorious and critical contribution of virtually every phase of electrosurgery takes the position that while theoretically electrosurgery should be the ideal method for the majority of operations, practically there are certain objections to its general use, since it does not outweigh the simplicity and safety of scalpel surgery. He concedes to electrosurgery a place not only in the surgical management of malignant growths but in the severely toxic types of goiter. He maintains that the characteristics of the high frequency current which render its use in malignant tumors so valuable are the ones that are indicated in toxic goiter and in certain infectious conditions. Mock also concedes that electrosurgery has a place in operations that are usually accompanied by profuse bleeding. In this respect it is not amiss to point out that the claims made some years ago that electrosurgery is bloodless surgery

have already been proved fallacious. Nevertheless it has a limited field of usefulness in operations where diminution of parenchymatous bleeding is essential. This has been fully demonstrated by Cushing⁽²⁾ in operations for the extirpation of brain tumors. On the other hand there has been for some time a growing tendency especially in certain parts of Europe to reduce classic surgery to the minimum and to perform almost all operations electrosurgically. While this tendency is not quite so pronounced in the United States, Mock, not without good reason, rejects electrosurgical procedures in amputations, as abdominal incisions, for gastro-intestinal resections, for removal of the gall bladder and the like. He maintains—and in this he is in accord with many authoritative surgeons—that scalpel surgery is not only adequate for the procedures but even preferable. We can readily see that there is still a diversity of opinion regarding the indications of electrosurgery, which without doubt is due to over-enthusiasm on one and pronounced conservatism on the other side.

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SPECIAL NOTICE EXAMINATION AMERICAN REGISTRY PHYSICAL THERAPY TECHNICIANS

Announcement is made of the next scheduled written examination for applicants who meet the requirements for the American Registry of Physical Therapy Technicians. The examination will be held in Kansas City, during the 14th Annual Scientific Session of the American Congress of Physical Therapy, at

the Hotel Kansas Citian. Applicants will report on Monday, September 9, at 9 A.M. in the Reception Room, 5th floor. Application forms and detailed information will be furnished by writing the Registrar, American Registry of Physical Therapy Technicians, 30 North Michigan Avenue, Chicago, Illinois, or after September 1st, Hotel Kansas Citian, Kansas City, Missouri.

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The Convention Committee wishes to announce that the Burlington has been designated the official route to Kansas City, for the intensive instruction course, September 5, 6, 7, and the 14th Annual Session, September 9, 10, 11 and 12. Air conditioned throughout, the Burlington is able to offer comfortable accommodations. General information may be had and tickets arranged for through the Central office of the Congress, or by writing to the General Agent, Burlington Route, 547 West Jackson Boulevard, Chicago.

LATIN AMERICAN CONGRESS OF PHYSICAL THERAPY, X-RAY AND RADIUM

The Latin-American Congress of Physical Therapy, X-Ray and Radium will hold its first annual Congress in Mexico City from August 29th to September 5th. As a scientific event it is of highest importance, for it will offer physicians of the United States an opportunity to cement their friendship with their colleagues of the Latin-American lands, and to exchange knowledge and viewpoints in the field of physical therapy, x-ray and radium. The medical activities will be divided into sections representing medicine and surgery, short, and ultrashort wave therapy, light therapy, electrosurgery, fever therapy, fractures in their various specialties, massage, radium and x-ray therapy and exercise.

SCIENCE, NEWS, COMMENTS

Seventh Annual Training Course for Medical Reservists at the Mayo Clinics

The two weeks' period, October 6th to 20th, 1935, has been selected for the Seventh Annual Training Course for Medical Department Reservists of the United States Army and Navy, at the Mayo Clinic, Rochester, Minnesota.

The program will follow the plan which has been so successful in past years. The morning hours will be devoted entirely to professional work in special clinics and study groups. Officers in attendance may select the course they wish to follow from the wide variety of presentations offered. The afternoons and evenings will be devoted to Medico-Military subjects.

The staff and faculty of the Mayo Clinic will present the professional training, while the Medico-Military Program will be under the direction of the Surgeon of the Seventh Corps Area (Army) and the Surgeon of the Ninth Naval District (Navy).

Enrollment is open to all Army and Navy Reservists of Medical Departments, in good standing. Applications should be submitted to the Surgeon, Seventh Corps Area, Omaha, Nebraska, or the Surgeon, Ninth Naval District, Great Lakes, Illinois — Enrollment is limited to two hundred.

The Surgeon Generals of the Army, the Navy and the Public Health Service, have all signified their desire and intention of being present during at least a portion of the course.

New Clue to Epilepsy Found by Hay Fever Tests

The super-sensitiveness which causes hay fever and hives provides a new clue to epilepsy and mental disorders, it was reported by Dr. Joseph A. Beauchemin of the Middletown, Conn., State Hospital at the meeting of the American Psychiatric Association.

The clue was gleaned from study of the red-den areas called wheals which appear on the skins of sensitive persons shortly after a drop of protein solution has been injected into the skin. The procedure of making these skin tests is familiar to hay fever and asthma patients and sufferers from similar disorders which physicians call allergic. The common feature of all the disorders, ranging from hay fever to migraine headache and hives, is a super-sensitiveness to protein from various sources: plant pollen; foods like milk, eggs, shellfish; feathers; or dust.

Proteins from meats and cereals and fats produced the wheals on the skin of eight-tenths of the epileptic patients he studied, Dr. Beauchemin reported. From this he concluded that a disturbance in the handling of these foods by the

body tissues is an important feature in epilepsy.

The wheals — positive reaction to the scientists — were caused in sufferers from mental disorders not by food or plant proteins but by solutions of gland substances. Patients suffering from dementia precox were super-sensitive to thymus and sex gland extracts, indicating a disturbance in these glands which may be only a concurrent symptom or may be of more significance.

Patients in the excited phase of manic-depressive disorder were as a group super-sensitive to adrenal, thyroid and pituitary substances. A possible over-activity of the pituitary and adrenal glands which in turn stimulates the thyroid and sex glands is Dr. Beauchemin's interpretation of the results of skin tests with this group. Patients in the depressed phase of the same mental disorder reacted to the gland substances in a way suggesting over-activity of the pituitary and of the cortex of the adrenal glands. More of these patients than of those in any of the other group showed super-sensitiveness to proteins from bacteria, indicating that they might be more susceptible to infectious diseases. — *Science News Letter*, May 25, 1935.

Seventh International Medical Postgraduate Congress at Brussels

The Tomarkin Foundation is organizing under the auspices of the University of Brussels, its VIIIth International Medical Post-Graduate Congress officially approved by the General Commissariat of the Government for the World-Exhibition.

This Congress dealing with diagnostic and therapeutic actualities will be held during the World-Exhibition from September 12 to 19 next in the Faculty of Medicine of the University in Brussels and from September 20 to October 2, at Spa.

For all particulars please apply to the Secretary, Tomarkin Foundation, Faculty of Medicine, 97, rue aux Laines, Bruxelles, (Belgique).

Osteopaths in Britain

The osteopaths here for some time have been clamoring for recognition, similar to that of medical men who having passed the requisite examinations are registered as legally qualified medical practitioners. On December 11th last, in the House of Lords, the second reading of the Osteopaths' Bill was moved. It was explained that the bill was for the purpose of securing the compilation of a register of osteopaths and the registration of the practice of this system of therapeutics. Another purpose of the bill was to impose upon practitioners of the system a prescribed standard of professional training and technical competence. The bill set up a Statutory Board which would keep a registry of

qualified osteopaths and supervise admission to the register, and the board would have the power to prescribe a course of study which would qualify for the practice of osteopathy. There was nothing in the bill which would enable an osteopath to gain admission to the medical profession. Lord Moynihan moved the rejection of the bill, which he said involved the negation of all the principles embodied in the Act of 1858. That Act enabled every person to discriminate between those who had and those who had not passed through the medical curriculum, between the qualified and the unqualified practitioner. If one particular theory of medicine were granted recognition contrary to the Act of 1858 it would not be long before other cults would be making appeals for recognition. The acceptance of this bill would involve a denial of and hold up to obloquy the whole of the scientific basis of medicine. Osteopathy had no connection with the main stream of scientific medicine.

Lord Dawson, the well known physician, followed in a like strain saying that the bill raised an important question of principle. While medical men were prepared to treat osteopaths as coworkers, they were not prepared to grant them equality of status in the science of medicine for which they had not had a proper training. For osteopathy to have the status of medicine without training in pathology would constitute a public danger.

Lord Horder, the distinguished physician, in referring to the bill after pointing out its patent objections, said that if the public really desired that the practice of osteopathy was legalized, perhaps it would be as well if they had their wish.

Another speaker said that if the bill became a law it would be countenancing the treatment of persons by partially qualified doctors. In any event, although osteopathy has a following in Britain, it may be surely predicted that in existing circumstances, there is not the shadow of a chance of this single system of therapy being placed upon, to all intents and purposes, an equal status with medicine. — (*Med. Rec.* March 6, '35.)

All Russian Congress of Physical Therapy

The third All Russian Congress of Physical Therapy was held at Odessa from August 25 to 30, 1935.

The principal subjects to be discussed at this session will be: hyperergy and physical therapy; acute infectious diseases and physical therapy; consequences of injuries and physical therapy; vegetative nervous system and physical therapy; short waves in biology and medicine; significance of the skin in the mechanism of physiotherapeutic actions. The discussions will be inaugurated by Prof. Brustein (Moscow), Prof. Anikin (Moscow), Prof. Nilsen (Sebastopol), Prof. Broderson (Leningrad), Prof. Plotnikov (Moscow), and Prof. Rachmanov (Moscow). Further information regarding this meeting may be obtained from the President of the Committee, Prof. S. A. Brustein (Moscow, U. S. S. R., Serebrjanny per. 5, room 7). With regard to visa and travel it is advisable for foreign guests to apply to the Travel Bureau "Inturist," which has representatives in all countries.

Radium Substitute Made in Greater Quantities

Radiosodium, hailed as a possible substitute for natural radium in yielding radiation useful in cancer treatment and industry, is now being produced "in somewhat greater quantities than reported several months ago" when Prof. Ernest O. Lawrence of the University of California made known his discovery. (*SNL*, Oct. 27, 1934.)

Because sodium as a constituent of common salt is one of the most common things in our daily life and because salt solution can easily be injected into the blood stream, scientists expect the new radiosodium to have practical applications in the future.

Prof. Lawrence makes radiosodium by bombarding sodium with the charged hearts of double weight or heavy hydrogen, called deuterons. When the deuterons are flung with an energy of 1,750,000 electron volts, sodium gamma rays are given off from the new radiosodium formed with energies of 5,500,000 electron volts. These are the world's most penetrating gamma rays. Even more important, the radiations continue to be given off for 15 hours.

British scientists have just discussed enthusiastically the possibilities of using radiosodium, although it is recognized that immediate use of this new substance may be delayed by high cost of production. — *Science News Letter*, April 13, 1935.

Nicotine Affects Nerve-Ends In Muscles, Not the Brain

A person poisoned by nicotine stops breathing because the nerve endings in the muscles of his breathing apparatus are paralyzed. The drug does not paralyze the breathing center in the brain, as has been generally believed.

These discoveries, which suggest a new method of treating nicotine poisoning, were reported by Drs. Harry Gold and Frederick Brown of Cornell University Medical College, New York, at the meeting in Detroit of the American Society for Pharmacology and Experimental Therapeutics.

Artificial respiration, rather than drugs to stimulate the breathing center in the brain, is the method suggested by the Cornell investigators for treating cases of nicotine poisoning in which breathing has been dangerously slowed or stopped altogether. Stimulating drugs can only make matters worse in such cases, they pointed out, because the partially paralyzed nerve endings require rest, such as can be obtained by artificial respiration. A substance like barbitol, which has a depressing rather than stimulating effect on the nerves, can abolish the convulsant action of nicotine, they found. An animal treated with this substance can survive an otherwise fatal dose of nicotine.

The new knowledge of how nicotine acts to stop breathing was obtained in several ways. First, direct application of the drug to the respiratory center in the brain caused marked stimulation of breathing, the Cornell investigators found, but even

very large doses of nicotine applied to the brain center failed to cause paralysis of breathing.

Secondly, nicotine was found to be more poisonous when injected into a vein than when injected into the carotid artery, the principal artery of the neck. If the action of nicotine was directly on the respiratory center, the reverse should have occurred, for when the drug is injected into the carotid artery it goes directly to the brain without passing through the lungs. When injected into the veins it goes to the lungs first. This, therefore, indicates that the seat of the toxic action is not the brain respiratory center.

Thirdly, it was found that after nicotine the power of the nerve endings to carry impulses from the brain center to the muscles was markedly reduced or abolished. Significant evidence was also obtained by means of a special device by which the minute electrical potentials produced in the brain were enlarged through radio tube amplifiers and recorded with the string galvanometer. When all signs of breathing had ceased after nicotine, the cells of the breathing center in the brain were still continuing to send down volleys of electrical discharges in a normal manner, showing conclusively that the nicotine did not injure the breathing center. — *Science News Letter*, May 18, 1935.

Spectroscope Proves Aid In Study of Hemoglobin

Exceptional progress toward a solution of science's old problem of the structure of hemoglobin was reported by Dr. David L. Drabkin of the University of Pennsylvania, who spoke at the Third Annual Conference on Spectroscopy meeting at the Massachusetts Institute of Technology.

Hemoglobin is that complex constituent of the blood which acts as a conveyor of life-giving oxygen to the various parts of the body.

Its importance, Dr. Drabkin said, is exceeded only by the difficulty of studying it. With the spectroscope, however, Dr. Drabkin has been able to conduct analyses far in advance of any carried on previously and although the problem

is still unsolved, tremendous steps toward the ultimate solution have been made.

Spectroscopy is the investigation of matter by a study of the light it emits. It has proved a powerful and accurate method of research in various scientific fields.

Further proof of this was added by Dr. Drabkin when he described the comparative ease with which spectroscopy had enabled investigators to study vitamin B, the oldest known, yet most elusive vitamin. The next step, he said, would be a method of studying the reflection spectra of tissues directly to replace the present method of studying biological substances in solution. This would be a great aid toward solving the hemoglobin problem, he said, since the very fact that it is now possible to work with it in solution only, is the main obstacle to a complete understanding of its mysteries. — *Science News Letter*, July 27, 1935.

Spectrum Changes With Age

Similar to the decrease in the efficiency of hearing ability as we grow older, C. F. Goodeve of University College advances the theory that vision in the violet end of the spectrum falls off also as we age. Goodeve publishes his results of observations confirmed by measurements in the British scientific weekly *Nature*. It has generally been assumed that a normal eye can see nothing much above 3,125 Angstroms, or deep violet. Goodeve and Professor Fabry of Paris have measurements to show that a good youthful eye can even do better than this. In Professor Fabry's youth his limit was 3,650 units, which is the line in the spectrum made by mercury when it glows as an electrified vapor. Now, at sixty-seven, he can no longer see the line, although he has reason to believe that his eyesight is normal for his age. The world thus starts to look a little more yellow than in youth. Goodeve holds that the protein matter in the lens of the eye absorbs more and more violet and ultraviolet rays as we grow older, so that they never strike the retina at all. — (*Med. Rec.*)

(Continued from page 492)

tain satisfactory results, but in general 104 degrees F. seem to give the maximum physiological response.

Paresis and tabes respond remarkably well to fever therapy. The results obtained here and by others need no brief in this paper.

Several diseases of a less clearly infectious basis which have responded well are tic douloureux, interstitial keratitis with chronic hypertrophic conjunctivitis, primary infectious neuritis, and, strangely enough, a case of weeping depressive psychosis was considerably improved.

With a disease such as atrophic arthritis in which a change in metabolism and circulatory rate are important, it is felt that the low pyrexias with a maximum temperature of 101 degrees F. are of considerable benefit. Hypertrophic arthritis is also probably helped to some degree by the eliminating property of fever.

Conclusion

We have presented outlines of some of the thought and experiences which have made fever therapy the relatively safe procedure it is today. The vision of Jauregg is fast becoming a reality in the treatment of many otherwise incurable maladies.

THE STUDENT'S LIBRARY

KURZWELLENTHERAPIE, DIE MEDIZINISCHE ANWENDUNG ELECTRISCHER HÖCHSTFREQUENZEN (SHORT WAVE THERAPY). By *Dr. Erwin Schliephake*, Giesen, Privatdozent für innere Medizin an der Universität Jena. Physikalischer Anhang von *Dr. L. Rohde*, München, Second, enlarged Edition. Paper. Pp. 196 with 145 illustrations. Price, 10-, geb 11.50. Jena: Gustav Fischer, 1935.

The extraordinary interest in short wave therapy is so manifest that any book on this subject is assured of a wide assembly of readers. Schliephake's pioneer work in this field is so closely associated with the foremost clinical advances in this domain that anything emanating from his pen is bound to be given serious consideration. The foregoing volume is the second edition of the first work on short wave therapy and comes enlarged and revised with the latest contributions and most authoritative opinions on the subject. It presents a general survey of the technical, biophysical, physiologic and clinical developments and action of short hertzian waves in relation to medicine and surgery. No one is more cognizant of the newness of this form of therapy than the author and nowhere are the facts so diligently and critically evaluated as they are in this text. The very nature of its spectacular possibilities is a danger point against its scientific development by its exploitation by opportunists and unethical individuals. Schliephake stresses this danger and warns against premature opinions of the enthusiasts and dogmatism of the inexperienced workers.

Within the space of nearly 200 closely written and beautifully illustrated pages there is presented a comprehensive exposition of the entire subject. Six of the seven sections concern themselves with the medical and clinical side of the problem. The seventh section is clearly of technical interest to physicists and was written by Dr. Rohde, assistant to Professor Esau at Jena. Of the first three sections, the discussion is limited to the technical nature and mechanical production of short wave radiation. Section four provides one of the most comprehensive surveys of experimental evidence of the action and thermic penetration of short and ultrashort waves thus far attempted in any work of a similar nature. The data include controllable experiments upon phantom models and upon living material, controllable by means of diathermy and other agencies. Equally as comprehensive is section six which deals with the clinical application of short and ultrashort waves. This part of the book is richly illustrated with luminous plates, charts and tables, and demonstrates the usefulness and often the possible restitution of moribund states to normal health in the most unexpected period of time. This work which has already come to be regarded as the most authoritative contribution on short wave therapy has attained more scholarly heights by providing us

with the best balanced survey of the possibilities, indications and limitations of short wave therapy thus far written by any individual in any language. Of the minor faults one may mention that it still lacks an index. To compensation the present edition provides one of the most detailed bibliographies on the subject.

THE TREATMENT OF RHEUMATISM IN GENERAL PRACTICE. By *W. S. C. Copeman*, M.A., M.A., B.Ch. (Cantab.), M.R.C.P. (London); Hon. Physician B.R.C.S. Clinic for Rheumatism, Peto Place; Assistant Physician, West London Hospital, Children's Department, and Hospital of St. John and Elizabeth; Physician, Cheyne Hospital; Consultant in Rheumatism to London County Council; Member Royal College of Physicians Committee on Chronic Rheumatic Diseases. Foreword by Sir *William Hale-White*, K.B.E., M.D., F.R.C.P., Hon. LL.D.; Consulting Physician to Guy's Hospital; Late President, Royal Society of Medicine; Chairman, Medical Committee, B.R.C.S. Clinic for Rheumatism. Cloth. Pp. 228. Price, \$3.25. Second Edition. Baltimore: William Wood & Company, 1935.

As noted above, the author of this book is on the staff of the British Red Cross Clinic for Rheumatism where all forms of treatment, especially physical are available. the extensiveness of clinical material is exemplified in the fact that there were 78,589 attendances of patients last year, and that 73 per cent were cured or improved of all the patients discharged during the past year. As this is the second edition of this book in a short time it evidently is fulfilling a need. Its success is probably due to the fact that the author has concentrated upon practical therapeutic methods, which are available for the general practitioner. Copeman calls attention that the Ministry of Health's recent report on chronic arthritis stressed that no scheme of treatment for arthritis can be considered complete unless use is made of physical methods under skilled direction. Therefore, half of the book is given to a consideration of the use of physical therapy. There is an excellent consideration of the use of heat, massage, baths, exercise and rest in the home. The specialized methods of using heat, diathermy, electrical muscle stimulation, the constant current and ionization are given. There are chapters on manipulation, baths, colonic therapy, actinotherapy, and on the choice of a spa and climate.

This book is of value to every one interested in arthritis. It demonstrates the reasons for the prognosis in chronic arthritis being twice as good today as it was thirty years ago, and shows that this was not so much owing to the introduction of new methods as to the renaissance of interest in the subject, the realization that drug treatment is of secondary value, and the resultant study of previously existing

methods of external treatment in the light of modern physiologic knowledge.

RADIO ROUND THE WORLD. By *A. W. Haslett*, Sometime Scholar of King's College, Cambridge. Cloth. Pp. 196 with 7 illustrations. Price \$1.75. New York: The Macmillan Company, 1934.

Here is a timely, entertaining and informative book on radio wave transmission written for lay people, but equally valuable to the more specialistic reader including the physician who desires his information in a non-technical dressing. It is timely because achievement in this field has been so rich and spontaneous that the historical background and evolution of this important science will soon be taken for granted unless a work of this nature places on permanent record the intriguing facts of its birth, development, status and future possibilities. Where but recently the radio was regarded as an entertaining diversion from the gripping realities of one's daily responsibilities, it is now realized that it is endowed with greater possibilities than heretofore suspected. It is now developing into a therapeutic agent as potential in medicine as its educational and entertaining features in relation to our social life. Not only has it made possible the spanning of great distances, but it has solved the problem of communication to such a degree as to make our world a much contracted sphere. The author points out and gives due credit to the prophetic genius of Clerk-Maxwell whose mathematical mind foresaw the link between light and electricity as demonstrated by his theory of electromagnetic radiation, and to the many pioneers in this field who soon may be forgotten on account of the increasing discoveries in radio transmission. This book therefore fills a needed place in the literature of the subject, and may well be regarded as an introductory exposition on the general nature and action of hertzian waves. In the space of ten chapters the author has presented an authentic exposition of the range of radio possibilities including a chapter of its developing use in medicine. The detail here incorporated is sufficient to assure not only interesting reading but has been so selected as to provide information of an entertaining and useful quality to both the lay and medical reader. The book contains appropriate illustrations and a special index. Every student of medical radiology should read this book.

THE 1934 YEAR BOOK OF GENERAL MEDICINE. Edited by *George F. Dick, M.D., Lawson Brown, M.D., George R. Minot, M.D., William B. Castle, M.D., William D. Stroud, M.D., George B. Eusterman, M.D.* Cloth. Pp. 843 with illustrations. Price, \$3.00. Chicago: The Year Book Publishers, Inc., 1934.

The present volume maintains the high critical standard set for past year books on medicine, with the additional feature of carrying a larger volume of selected material. The book is by far the most representative review of current contributions to the literature of internal medicine in the English language, judged both from the quality of the literature incorporated, and the list of distinguished

editors responsible for this selection. The cogent editorial comments appended in bracketed form are of great value to the reader. The progressive physician will here find the richest source of information, information selected for its timeliness and usefulness. The material is classified under five sections. Part 1 deals with infectious diseases; part 2 with diseases of the chest; part 3 with diseases of the blood and blood-forming organs; part 4 with diseases of the heart and blood vessels; part 5 with diseases of the gastrointestinal tract. The fact that over 800 pages have been utilized to present a critical review of the best achievements in medicine of the past year is an index of the diligent labors of the editors as well as the industry and progressiveness of the profession. The above discussed year book thus contains the most essential and fruitful information of the world's progress in this field. The entire series has come to be regarded as an indispensable supplement to the educational armamentarium of the progressive practitioner of medicine. The reviewer ventures to offer a constructive suggestion, namely, that the future series be brought up to the size and format of the new year books on Radiology and that each editor preface his department with a comprehensive review of the outstanding and important advances in his field.

ATOMIC STRUCTURE AND SPECTRAL LINES. By *Arnold Sommerfeld*, Professor of Theoretical Physics at the University of Munich. Translated from the fifth German edition by *Henry L. Brose, M.A., D.Phil., D.Sc.*, Lancaster-Spencer Professor of Physics, University College, Nottingham. Cloth. Pp. 670. Price, \$10.80. New York: E. P. Dutton & Company, Inc., 1935.

This volume is essentially a thesis on Spectroscopy. It contains a most complete compilation of data on the theories and laws of radiation as well as theories on the structure of the atom. The character and multiplicity of the mathematical expressions, as one glances hurriedly through the book, might leave the impression that it is too technical for the practicing physician to understand. When reading the text more carefully however, a non-mathematical person can learn a good deal about the recent theories and advances in the field of radiation and on the structure of the atom, even if one must skip over rapidly the mathematical treatise. The first chapter of this volume contains a review of the established laws and theories on atomicity of electricity, cathode and positive rays, alpha and beta rays, roentgen and gamma rays, and radioactivity. The second chapter discusses the hydrogen spectrum and its interpretation by the Quanta theory and Bohr's theory of the atom. A section is devoted to the newer forms of mathematics as a means of understanding the atom. Chapter 3 is an exposition of the natural system of elements. Chapter 4 deals with the x-ray spectra and methods of measuring wavelengths of x-ray lines. Chapters 5, 6, and 7 contain more information on the spectral lines, whereas chapter 8 concerns band spectra. Physicians, who are interested in or are specialists in radiology and radiotherapy, should find this volume a valuable addition in their library.

CLIO MEDICA. A Series of Primers of the History of Medicine. Vol. XIII. German Medicine. By *W. Haberling* M.D., Professor of History of Medicine, Academy of Dusseldorf. Translated by *Jules Freund*, M.D. Cloth. Pp. 160 with 9 illustrations. XII-o. Price \$1.50. New York: Paul B. Hoeber 1934.

The medical history primers are too well known to need an introduction. Under the group title of "Clio Medica" Mr. Hoeber has rendered the medical profession a real service by providing many historical facts either about branches of medicine or about certain endeavors of olden times. The fact that twelve books have preceded the present little volume also shows that medical men are taking a deep interest in the history of their profession. In the present volume the distinguished author has given a brief but comprehensive review of medicine in Germany from the oldest times to the present day. Beginning with antiquity and the middle ages he proceeds with a chapter labeled as the awakening of German medicine. In this Paracelsus is given more space than his contemporary practitioners and accorded a fairness which few historians have granted that remarkable man. Others have painted him as a charlatan and a buffoon but Professor Haberling shows him in a different light, though he agrees that his life was a tragic one. The remaining chapters take up the thread from the seventeenth century to present times. So far as contemporary history is concerned we feel that with due allowance for an author's privilege of discernment he could have been a bit more critical and more liberal. Thus the greatest modern German surgeon, August Bier, is disposed of under the section "anesthesia" as the introducer of spinal anesthesia with cocain. This is only partly true. In addition Bier's revolutionary studies in physiologic surgery (therapeutic hyperemia!) are ignored, to say nothing of his ingenious osteoplastic amputation of the lower leg. In the group "gynecology" Fritsch, who has done so much for that specialty,

is not even mentioned by name. Aschheim, Zondek, Nicoladoni, Sauerbruch, the great thoracic surgeon, are a few of many who have been "distinguished" by omission. On the other hand the author has pointed out certain facts about the university training of medical students, about the harmful laws and economic conditions under which German physicians can only eke out a bare existence, the frank exposition of which merits due recognition.

PHYSIOLOGY IN HEALTH AND DISEASE. By *Carl J. Wiggers*, M.D., Professor of Physiology in the School of Medicine, Western Reserve University. Cloth. Pp. 1184, illustrated with 182 engravings. Price, \$9.00. Philadelphia: Lea & Febiger, 1934.

This book, written not only for medical students is one of the most scholarly contributions of the physiologic background in health and disease. As physical agents profoundly influence biologic processes, it is important for the physician also to have a complete understanding of the changes taking place in the living organism. The objective of this book is a complete understanding of the functional disturbances of patients leading diagnosis and treatment in the physiologic manner. The author stresses the general principles of physiology, outlines and surveys the functions of the various tissues, organs and systems, and correlates physiologic alterations produced experimentally with aberrant manifestations illustrated in patients. The text is illustrated by numerous charts, graphs and figures. The bibliography is extensive and complete. It is therefore an outstanding reference work on its subject. It will be invaluable to anyone interested in the use of physical agents in treatment, as the present era might be referred to as one of physiologic medicine and surgery, in which the prevention of abnormal states and the restoration of function constitute the modern ideal of therapy.

Normal Stature Depends on Balance of Two Glands

Does normal stature depend on proper balance between the big thymus gland in the chests of growing children and the tiny pineal gland in their heads?

Evidence that it does was presented by Dr. Leonard G. Rowntree of the Philadelphia Institute for Medical Research before a group of physicians. He is the leader of a research team which has done most to solve the mystery of what these two little-understood glands are good for.

Dr. Rowntree and associates have produced a dwarf race of rats by treatment with pineal gland extract. Last spring they demonstrated that treatment with thymus gland extract speeded up growth and development in rats at an amazing

rate, although it did not produce giants, Dr. Rowntree said at that time.

"These glands are concerned in the growth of the young and have hitherto not received the consideration in biology and medicine that seems warranted."

Dr. Rowntree showed a picture in Alice-in-Wonderland with a magic mushroom. If she ate from one side of the mushroom she became a giantess. If she ate from the other side she became a dwarf. The action of the thymus and pineal glands Dr. Rowntree likened to this fable.

Associated with Dr. Rowntree are Dr. A. M. Hanson of Faribault, Minn., who made the thymus extract used in the research on that gland, and Dr. J. H. Clark of the Philadelphia Institute for Medical Research. — *Science News Letter*, December 15, 1934.

INTERNATIONAL ABSTRACTS

Indications and Successes of Short Wave Diathermy In Circulatory and Renal Diseases. (Ueber Indikationen und Erfolge der Kurzwellendiathermie bei Erkrankungen des Kreislaufs und der Nieren.) Zoltan Rausch. Fortschr. Therap. 10:394 (July) 1934.

Short wave diathermy in circulatory disease affects pains as an antispasmodic, and exerts a favorable influence on hypertension. Since short waves act merely symptomatically on cardiac pains in cases of angina pectoris, aortitis, and myocarditis medication and dietetic measures should never be dispensed with. In addition to the symptomatic effects in some cases increase of heart action and improvement of the circulation become manifest. The best results were obtained in angina pectoris, not only by alleviation of pain but also in lessening the intensity of the attacks and prolonging the free intervals.

In decompensation the treatment increases diuresis. Cases with coexisting hypertension showed a fall of blood pressure of 30-60 mm. Hg., which persisted for a long period after treatment.

The method of application in hypertension is as follows: A condenser electrode of 300 square centimeters is applied over the region of the kidneys, a parallel one of equal size to the abdomen, with the patient in the recumbent posture. The electrodes are held in place with sand bags, which must be replaced by a bandage wound around the body for the sitting position. To localize the current to the kidneys a felt pad should be placed beneath the electrode by which an air-gap of about 1-2 cm. between the body and the electrode is obtained. The current intensity is regulated according to the subjective sense of heat, never surpassing 2-2.5 ampères.

Prolonged success with short wave diathermy in hypertonic patients depends on the anatomical changes in the kidneys and in the vessels. The best results are had in the initial stages of nephro-sclerosis, while hypertension is still unstable, and organic changes of the renal parenchyma have not yet taken place.

Actinomycosis—Short Wave Treatment. E. Wessely.

Monatssch. Ohrenheilk. u. Laryngo-Rhinol., No. 3, 1935.

The author reports on three cases where cure was brought about within a few weeks with short wave treatment. He recommends this method for those cases which are not cured by means of x-ray treatment and iodine therapy.

Endocervicitis. George Joyce Hall.

California and West. Med., 41:125 (Aug.) 1934.

The author regards the actual cautery as the method of choice. The mild case is treated as an office procedure and rarely needs an anesthetic.

It generally requires from two to four weeks for complete healing. As a consequence, if given a choice, Hall prefers cauterizing a few days after menstruation has ceased.

The electric knife may be used to obtain a very good removal of the same amount of tissue as is done in Sturmdorf's tracheloplasty.

Electrocoagulation when properly carried out will give almost universally good results. It is simple and may be used as an office procedure as in cautery.

Conization of the uterine cervix is considered by many a great improvement over the uncontrolled cautery and coagulation destruction. The technic is simple and the results excellent. There is more bleeding after conization than after cauterization, and there is also the occasional failure to destroy all of the infected glands, which requires a repetition at a later date. No one method, however, is indicated in all types of cases.

Electrosurgery of the Bladder and of the Vesical Outlet. (Die Elektrochirurgie der Blase und des Blasenausgangs.) R. Uebelhoer. Deutsche ztschr. f. Chir. 243:655 (Oct.) 1934.

All electrosurgical measures to the bladder and to the vesical outlet being dangerous, should be avoided as they result in tissue coagulation.

It is improper to make use of open coagulation for a large vesical carcinoma. For small carcinomas, one might attempt transurethral coagulation, the grade of malignancy indicating whether to continue the treatment transurethrally or to resect. Open operation of vesical papillomatosis is objectionable, even though electrosurgical measures should be added. Changes of the sphincter vesicae, no matter whether of a nervous or inflammatory character or caused by a small adenoma of the prostate, call for substitution of transurethral resection by a loop for wedge-shaped excision.

For all types of hypertrophy of prostate fusing incision with a loop is preferable to a coagulating groove. Very little coagulated tissue should be left behind, as there is a risk of infection, secondary stone formation, and of hemorrhage during the separation of the scale. In suitable cases suprapubic or perineal prostatectomy should not be neglected. In certain types of incontinence the proper method for treatment is by coagulation.

Common Misconceptions Concerning Massage and Mechanotherapeutics. E. Cyriax.

Brit. J. Phys. Med. 8:92, 1933.

Surrounding the treatment of disease by active and passive movements there are many erroneous views. Not only are nomenclatures, as used, extremely faulty, but many misconceptions also obtain in relation to the active application of this art. Some of these erroneous views are due to the fact that many who have written on the subject have quite an insufficient knowledge of the subject. A very common misconception is that a period of rest should follow every massage treatment. This is quite without physiological basis, for both clinical and experimental evidence shows nothing whatever in the nature of a strain or severe reaction for which rest is essential in order to ensure recovery.

In prescribing muscle massage, most medical men have in mind stimulating the venous and lymphatic return. While this may be applicable in situations where there is stasis and oedema, it is not true in muscles that are weakened because of disuse or nerve impairment. Because of experimental researches we now definitely know that massage influences muscles by stimulating their nervous elements. Since effleurage, so frequently employed, can produce no stimulatory effect, it is little to be wondered at that the treatment of infantile paralysis and other muscle dystrophies is often very slow in showing any improvement. Since many are central in origin reeducation is the indication that should chiefly be served.

Heating of Deeper Parts in Short Wave Field. F. Schultze-Rhonhof, and W. Rech.

Arch. f. Gynak. 157:468 (Aug. 18) 1934.

Schultze-Rhonhof and Rech report observations which indicate that the application of a 30 meter wave in the short wave field does not produce a measurable heating of the deeper layers of the tissues. Such an effect has been demonstrated in preliminary experiments on bread. The fact that this is not the case in human tissues proves the great significance of the heat regulators of the human organism. This lack of heat action in the deeper layers in short wave therapy of abdominal organs concerns of course only the mechanism of the therapy and does not involve a criticism of the efficacy of the treatment, which is often quite clear. The authors' experiments provided only a certain insight into the thermo-electric but not into the electrochemical actions of the short wave therapy.

Light Sensitive Dermatoses. Nelson Paul Anderson, and Samuel Ayres, Jr.

J. A. M. A., 103:1279 (Oct. 27) 1934.

The problem of light sensitivity is one in which the final solution will probably be found by the biochemist. It appears to be bound inseparably with sulphur metabolism and through sulphur metabolism with the amino acids and perhaps also the vitamins.

Evidence has been presented to show that dis-

turbed sulphur metabolism plays a rôle in the production of high sensitivity and further that the exact status of the porphyrins in light sensitivity is as yet undetermined. The high incidence of lupus erythematosus following severe sunburn is recognized and certain cases will respond to dietary measures when all other known remedies have failed. Certain drugs, foods such as buckwheat, focal infections or physical allergy may at times be light sensitizing agents. Whether disturbed sulphur metabolism bears any relationship to vitiligo is yet to be discovered. What part faulty liver metabolism plays in the causation of actinic dermatoses and of pellagra is not known. It appears that liver therapy is of definite value in both conditions.

X-Ray Therapy of Arthritis Deformans. (Roentgentherapie der Arthritis Deformans.) C. von Pannewitz.

Deutsche med. Wchnschr. 59, I, 614, 1933.

From his experience with 1500 cases of arthritis deformans treated with x-rays, the author concludes that the age of the patient and the location of the disease are without decisive influence upon the result, but early treatment is advantageous. The demonstrable changes of arthritis deformans are not influenced by radiation therapy; their degree is of importance in the spine, not in the extremities. An optimal technic of x-ray therapy was established. The percentage of improvement is 94.

Myxodema of a Radiologist. (Myxödem bei einem Röntgenologen.) E. Schmiedt.

Fortschr. a. d. Geb. d. Roentgenstr. 49:593, 1934.

After discussion of the literature about the effect of x-rays upon the thyroid and about occupational x-ray injuries, a case of myxodema in a radiologist is described. The symptoms occurred after 13 years of roentgenological work with primitive x-ray equipment, and without proper protection of the neck region. At the same time anemia and leucocytosis were present, indicating also the lack of x-ray protection. The blood changes disappeared after a two month leave; the myxodema had to be treated by thyroidin application, which resulted in marked improvement.

Heat Cramps in Industry: Their Treatment and Prevention by Means of Sodium Chloride. D. M. Glover.

J. Ind. Hyg. 13:347, 1931.

The literature on the subject is thoroughly reviewed. From clinical and experimental evidence it is concluded loss of large amounts of salt in sweat is the direct etiologic factor in the production of cramps. Heat cramps are readily relieved by the administration of salt solution. Cramps are prevented by the prophylactic administration of sodium chloride in tablet form.

Diathermy and Histamine in Polyarthritis. A. Dzsinič.

Wiener klin. Wchnschr. 47:1021 (Aug. 17) 1934.

In cases in which, after a previous acute polyarthritis, relapses developed so that the disorder was in the subacute or the chronic stage, Dzsinič resorted to the injection of histamine and to diathermy. The subcutaneous injections were begun with 0.5 mg. of histamine, and, when there was no noticeable reaction, the dose was increased to 1 mg. The injections were usually made near the involved joints. In the beginning of the histamine reaction diathermy was applied to the diseased joint for twenty minutes. These treatments had to be given from ten to twenty times and in a few cases more often. Of thirteen patients treated in this manner, five were cured, five greatly improved, two slightly improved and one remained uninfluenced. The author thinks that further trials with the method are justified. He ascribes the efficacy of the treatment to three factors: (1) the desensitizing action of histamine, (2) the general physical action, and (3) the deep hyperemia produced by the diathermy in addition to the more superficial vasodilatory action of histamine.

Absence of Light and the Reproductive Cycle in the Guinea Pig. Edward W. Dempsey, Hugh I. Myers, William C. Young, and David B. Jenkinson.

Am. J. Physiol. 109:307 (Aug.) 1934.

The confinement of 30 female guinea pigs in a completely darkened room was followed after the first oestrous period by a loss of the tendency to come into heat at night rather than during the daylight hours. In addition, the mean point of oestrus occurrence during the period October 15 to December 15, 1933 was one hour sixteen minutes earlier than during the period February 15 to May 15, 1933. This shift is 6.2 times its probable error and is of the same order of magnitude and in the same direction as the change in the time of sunset.

From these data it has been concluded that the change from daylight to darkness is the factor which is responsible for the more frequent occurrence of oestrus between 6 p.m. and 6 a.m. than between 6 a.m. and 6 p.m.

Observations on the duration of oestrus and the length of the reproductive cycle, examination of the vaginal smears, and a determination of fertility revealed that in these respects the reproductive cycles of animals excluded from any influence of light was normal. From this it is concluded that exposure to light is not necessary for the existence or maintenance of the reproductive rhythm in at least one polyoestrous species, the guinea pig.

Successes and Failures of Short Wave Therapy. (Erfolge und Misserfolge der Kurzwellen-therapie.) P. Liebesny.

Wien. med. Wchnschr. 84:1132 (Oct.) 1934.

The author emphasizes the superior and positive effect of short wave therapy in acute inflammatory processes, particularly in furunculosis of the upper and of the lower lip, carbuncles of the neck of diabetics, abscesses of the sweat glands, phlegmon, puerperal mastitis, infections due to injuries, and serious phlegmons of the throat. Among chronic inflammatory processes actinomycosis should be mentioned, for which application of ultra short waves (4 m.) produce the best results. Favorable effects were obtained also in osteomyelitic processes, tuberculous of the pleura, tuberculous of a joint and of the urogenital apparatus. Short wave therapy is most valuable for diseases of the vessels of extremities. Patients with arteriosclerotic gangrene, with gangrene from frost-bite, diabetic gangrene, disbasia angiosclerosis and Raynaud's disease, showed favorable results in about 60 per cent.

Efforts tending to substitute short wave therapy for malarial therapy in cases of metasyphilis and of progressive paralysis must be considered as absolute failures. This applies to schizophrenia.

Short Wave Therapy In Gynecology. (Kurzwellentherapie in der Gynäkologie.) E. Vogt.
Strahlentherap. 51:526 (Nov.) 1934.

Vogt made use of an apparatus of the Siemens-Reiniger Works called Radiotherm. In acute inflammations such as pelveoperitonitis and tumors of the adnexa he applied irradiation, as soon as the symptoms and the pain abated. New swellings of the adnexa due to mixed infection following miscarriage or delivery were attended by a speedy healing process, under short wave treatment. Tumors of the adnexa are favorably influenced without any complications setting in. In some chronic gonococcal tumors of the adnexa of long standing short wave irradiation relieved patients of their symptoms, enabling them to return to their work.

Equally favorable results were obtained in post-appendiceal abscess, in postoperative infiltration of the cul-de-sac, and in mastitis. In a case of inflammation of both mammary glands necessitating an incision of the right breast, that of the left breast, became unnecessary under short wave treatment, 11 exposures having caused the infiltration to retrogress without abscess formation.

A very remarkable recovery was observed in a case of very serious gonococcal arthritis of the knee joint, the function of which was entirely restored. This case was exceedingly successful, considering the severity of the nature of the case which was refractory to all methods of treatment.